Industrial QUALITY CONTROL

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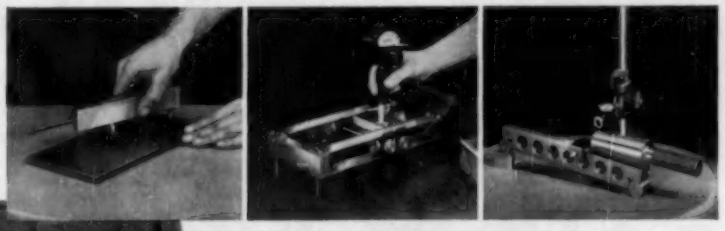

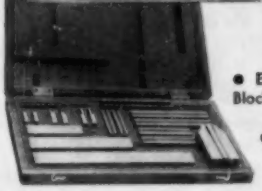

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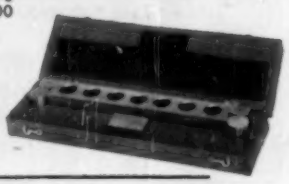

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From the President's Desk

All-Day Conferences

Monthly evening meetings of our Sections are an almost universal custom, and they have been a major factor in the growth and development of our Society. Programs in these meetings are varied, including such items as technical papers; the organization and operation of a quality control program; education and training of quality control; ladies' nights and other social events.

In this message, though, I want to discuss some of the possibilities of All-Day Conferences as another type of program for Sections to consider in their general planning. To my knowledge no complete canvass has been made on the subject, but one report indicates that approximately one-fourth of our Sections have scheduled at least one All-Day Conference during this past fiscal year—this in addition to Regional and Divisional Conferences in which they participated.

Is there a pattern to these conferences, and what are some of their advantages? For one thing, Saturday seems to be a favorite day. Generally, two or more panels run simultaneously in the morning, with an industrial leader as luncheon speaker, and two or more panels again in the afternoon. Several hundreds (or even thousands) of printed announcements are sent to industries and individuals in the area, with the result that many persons become interested in quality control for the first time either through these notices or through the conference itself. Moreover, these All-Day Conferences become a logical source of new members; for names of persons attending are added to mailing lists to receive notices of future meetings and activities of the Section.

A panel on basic concepts and functions of quality control is a favorite at many of these Conferences and is often repeated year after year. By scheduling simultaneous speakers and panels from electronics, chemicals and plastics, management, or other topics of wide appeal, it is often possible to attract appreciably larger numbers to these All-Day Conferences than come to regular Section meetings. Usually we see a welcome "change of pace" through the Conference after the first few years of Section activities. It should be said, too, that these conferences provide a means of interesting the quality control "sophisticate" and the "novice" at the same time by the simple expedient of having different panels running concurrently. History suggests that the number attending is increased as the number of different topics is increased and as speakers of recognized ability are included on the program. Of course, a major function of these conferences is to extend the awareness of quality control methods and the activities of the American Society for Quality Control. Consequently, it is necessary to scale the registration fee prudently.

Whenever possible, there are definite advantages in having the conferences on the campus of a nearby university. In so doing, a dual function is served; the attention of the university is directed toward our Society and quality control courses may be added to their curricula and training thus made available to our members. At the same time, attention of our members is directed toward courses in quality control being offered by the university, especially in evening sessions.

Since many Sections have indicated an interest in the possibilities of these All-Day Conferences, a memorandum covering some of the high spots of operation has been prepared in outline form and is available on request by writing to the ASQC headquarters office in Milwaukee. This All-Day type meeting might be just what is needed to gain the recognition some of you may seek locally.

DALE L. LOBSINGER

How Quality Control Helps Solve Administrative Problems*

J. D. STOCKTON

Vice President, Illinois Bell Telephone Company, Chicago, Ill.

If, in what follows, I sometimes refer to the telephone business, I hope you'll forgive me. It just happens to be the business I know best. In this business we're constantly aware of one thing—we want to keep feeling we can always learn more. This situation exists not only on the technical side, but also in every other phase. Because this has been true over the years, we like to feel that it's one of the basic reasons which helps in our efforts to attain a goal of a constantly improving and more pleasing service.

In our search for the better way in every phase of our operations, one of the many things we've used is Quality Control. Much of top management's time in any company is spent in making decisions. In a small company most of these decisions are likely to be "situation" decisions—that is, made on the spot, one at a time. As a company grows, the need arises for too many decisions to permit each one to be considered individually by top management. So these are delegated to lower management. Thus, top management has to concentrate on major decisions, mostly policy matters. At the same time, it has to be sure the multitude of "situation" decisions are being made fairly and consistently with a good sense of proprietorship.

The idea of inspection by the use of sampling is not a new one with us. At the turn of the century we were already taking sample observations of the accuracy, speed and quality of telephone service. Today about 80 different aspects of such service are under constant scrutiny. Our purpose has remained unchanged for this period of more than a half century, namely:

1. To spotlight weaknesses. This enables us to take administrative action to improve the service.
2. To foster internal competition by comparing the results of various units in our organization.
3. To help enable us to recognize capable people.

For example, in each call we handle, we're very interested in quality measurement in two basic areas: speed and technique. In the speed element, we want the operator or dial equipment to respond quickly when a customer makes a call. Also we want the operator or equipment to release the line or long distance circuit promptly at the end of the call so others can use the facilities.

Here are some of the questions we ask in technique: Was the call handled accurately? That is, did the customer get his party, and was the final report correct? Was the call free from objectionable interference? And did the servicing of the call follow procedures designed to avoid erroneous handling?

In applying quality control to the handling of telephone calls, we must keep in mind two basic facts. One is the nature of the product. Each call is custom made to suit the individual customer. The other is the limitation of measurement and sampling. We can't sort the good product from the bad. We can't reject. We can't use a go no-go gauge. We can't scrap and rework. We can't stockpile the perfect calls. Our product—the call—must be measured during the very limited time it is created and used.

To obtain these measurements we use a group of observers. They make stop-watch measurements of various time intervals and jot down notations of the technique factors, covering only the period while the operator or equipment is establishing the connection. Results from the observers are summarized to determine the percentage frequency of each of the types of defects. This material is then reduced to an index of performance. Here then is an illustration of quality control of an instantaneous service. Performance indices of this type can be combined with Customer Opinion Surveys—which are a sort of overall quality measuring stick at the end of the pipeline—to gain a picture of just how we are doing.

Another application of sampling techniques which we in the Bell System have used for many years relates to the inspection of manufactured products. The Bell Laboratories, which is the research unit of the Bell System, established the specifications and the sample techniques used by the Western Electric Company, our supply and manufacturing arm, in producing products designed by the Laboratories. The Western Electric Company, since 1904, has maintained a Supplies Inspection Organization. I understand it is perhaps the oldest continuously active group of its kind in American industry. In addition, of course, Western Electric plants have quality control processes all through them. If any of you have visited Hawthorne for example, here in Chicago, you may have seen the quality control procedure, which consists of a group entirely independent of the line organization, sampling the various products on a completely random basis.

In getting the notes for this talk together, I asked myself why we, or, for that matter, any firm, might consider quality control a useful tool. I listed these four simple and perhaps obvious answers.

1. To help in administering a large operation. Each transaction, each operation, can't be individually scrutinized — yet management must have overall knowledge of them. Quality control is a most helpful answer.
2. To help set certain standards of performance. Customers expect a

*Based on remarks at a luncheon meeting November 8, 1955, in connection with a two-day training course sponsored by the Chicago Association of Commerce and Industry and the Chicago Section, American Society for Quality Control.

relatively similar product or service regardless of where or when purchased. Clearly a control of quality is required.

3. To assist in the complicated balancing of cost control and quality performance. As you all know, quality could be "controlled" upward to the point of impossible costs. But with this tool, management has a device to facilitate this important policy determination, particularly useful in this highly competitive period.
4. To improve constantly the quality of the product or service furnished. In this day, it is trite to say the company that is only standing still, is, in effect going backwards, competitively. Quality control helps provide the fulcrum by which a management can continuously improve performance and product.

On the operating side of the Bell System, Illinois Bell serves some two million customers with more than three million phones in 359 communities. It takes about 40,000 employees to do the job.

It is with some misgivings that I mention our size for it's no attribute in itself. In fact, the trick is to be big enough to be small—small in the sense of adaptability to varying situations such as large cities, small towns and so forth. The management man in the field must be equipped both with judgment and authority to act and to have knowledge of the resources he can command.

Obviously, all of this knowledge can't be detailed information. From a practical standpoint, it must be simplified. That means we have a great need for much information in capsule form.

Our large investment and our low rate of capital turnover mean that we must always take a long range point of view. We must be particularly interested in scientific applications which help to improve our service, reduce our costs, or both. Our broad objective is to furnish the best phone service at the least cost consistent with good personnel, financial, and operating practices.

We're planning to make more and more use of scientific and technical advances including such things as:

Technological innovations, like the Bell Labs transistor—a pea-sized amplifier that does the work of a vacuum tube.

Better merchandising techniques and market research.

Better data processing, including the use of high speed computers.

Better statistical and mathematical techniques.

We're applying process control to such things as typing and other clerical work, and to operator and mechanical errors. We know in a human world it's impossible to get perfect quality. And we're also aware that if you set your quality standard too high, it'll cost too much. And the same thing is true if you set your quality standard too low. For too many errors or defects mean a waste of time and money. We have actually found on some service inspecting that the cost of the inspection was more than paid for by the savings in expense through error elimination. It seems to me this is very significant.

Currently we're applying quality control to cut down clerical errors in the accounting department. We're using it to equalize the number of telephone calls handled by the various units of equipment in our central offices. Also, it is being applied in controlling defective units among the switches and relays, which are the workhorses in the automatic brains of our central office dial equipment.

Not too long ago we were verifying 100 percent of all keypunching done in classifying the work time of our plant craftsmen. Quality control has changed that. The control chart showed that experienced keypunch operators needed only a sample verification. One hundred percent verification still is being done on the work of inexperienced keypunch operators.

So much for the present. What about our thoughts for using quality control in the future? We'd like to extend it further in the areas where it now is being used. And we'd like to apply it to other fields such as sickness, absences, and accidents.

Also, we'd like to extend the quality control approach to performance indices of various kinds, both in our offices and in the mechanical operations of our equipment.

We hope to use it more in helping to maintain our dial equipment in our central offices. These mechanisms are subject to quality control from manufacture through installation. But once they're put in service, the maintenance work on this equipment is strictly a matter of management judgment. We feel certain that with properly designed quality control we'll be able to make better decisions as to when replacement or repair work is necessary.

Along about here, in thinking about this talk, I found myself bothered about an important facet of the use of quality control. That is, the human side. I wondered if we wouldn't be in serious error if we use quality control too coldly, too mechanically.

It seems to me any installation of quality control brings with it the need for a large measure of human relations. I can think of no greater abuse of management authority than to pace a worker or a group against a cold statistical formula which is neither understood nor accepted. Surely the use of quality control must carry with it the normal precepts of good personnel relations. This would include such things as:

Participation—at least by key people and to the extent practicable—in efforts to improve quality.

Explanation of the purposes and uses—the whys—of quality control.

Enlisting group interest and enthusiasm for performance standards and measurement.

Quality control can be a great help in human relations. It keeps us from criticizing a supervisor when nothing is wrong. Better still, it provides a barometer which tells us when work is exceeding the standard performance. This, of course, calls for commending the employee or group.

A control chart does another important thing in the field of human relations. It permits a management person to see at a glance how his work, and that of his unit, rates according to standard. He's not kept in the dark nor does he have to wait for a word from a superior to take appropriate action when needed.

We use a series of conferences to explain the how and the why of quality control to our people. And this has paid dividends. More important, we try and do a lot of listening to questions and comments and suggestions from our employees. Sometimes we pick up ideas from them. It's not unusual to have skeptics when such a program is initiated.

We had one outspoken woman who made no bones about her doubts and dislikes of quality control when it was applied to her clerical section. She couldn't believe it would do all that we'd outlined. Six months after we

started using it, she told us she'd been wrong, that it worked just as we said it would.

To summarize briefly, I'd like to mention five advantages in applying quality control to administrative problems:

1. It motivates managements and employees to do a better job.
2. It establishes standard levels of quality performance.
3. It saves time in verification work.
4. It sames time in management decisions.
5. It carries upper management objectives to the whole organization.

Quality Audits of Paperwork Operations—The First Step Toward Quality Control*

GERALD J. GLASSER

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A Management Problem

The increasing flow of paperwork and records to office desks has made it increasingly difficult to maintain high standards of quality. While it is generally agreed that accuracy and quality in clerical paperwork operations are desirable, two problems arise in reaching these goals:

- in quality; how to improve the quality level in the finished paperwork product, and
- in cost; how to minimize the expense of attaining a high quality level.

Suggested solutions in many cases offer only check and re-check expense as an alternative to error costs. This alternative may be acceptable, but today management has another weapon in the war on error. It is the sampling theory of statistical quality control, another application of the statistical theory that has been proven in other fields and recently proven in paperwork operations. A number of articles have been written on the application of this new tool. (See list of references at the end of this article.) The present article suggests a first step in the design of a successful quality control program. It considers a quick and ready prerequisite to a clerical quality control program.

The Quality Problem

In clerical paperwork procedures, many different types of errors arise. Their frequency (i.e., their error rates) also varies according to the nature of the operation. In practice, no clerical process is ever completely free of mistakes.

For example, in filing, a report may be filed in the wrong place, the wrong letter may be picked out of a file, or an incorrect requisition may result in error. In posting operations, the transcription may be miscopied, or it may be incorrectly placed. In numerical procedures, calculations may be in error. Wrong information may be punched in key punching operations. In correspondence, typing, spelling, grammar, or content may not be of a high quality. More complex errors are involved in such procedures as credit reporting, interpreting purchase orders, and underwriting analyses.

The Cost Problem

Cost is excessive when management spends more money correcting mistakes than it would spend in allowing them to stand. For each operation, there is an optimum level for the quality standard: a balance between the cost of maintaining it and the cost of poor performance.

In many cases a level of perfect accuracy is unwarranted; in almost all cases it is unobtainable. Human variation defies control in many areas. The idea that 100 percent inspection is a cure for such inaccuracies as do occur is usually erroneous. Inspectors and checkers are human, and, beset by monotony and fatigue, they too make errors. Even more important, most checks are designed to correct only the mistakes themselves, and do not consider the causes of errors nor point to any remedy.

Even if high accuracy is obtained, a complete check is certain to be expensive. It is likely to result in a high price for a low return.

The Quality Control Solution

A quality audit applied to paperwork is a guide in solving the problem of obtaining maximum accuracy per unit cost. It develops quantitative bases which afford management reliable and valid criteria to consider in making decisions concerning quality and cost. The data supplied to management are as follows:

1. The existing level of accuracy for the operation,
2. A realistic target level to be attained,
3. The types of "errors" made,
4. The frequencies of these "errors" (indicating trouble spots),

*This article is the result of a Research Fellowship sponsored and directed by the National Records Management Council. It is intended as a non-technical functional report to management on an application of statistical theory.

5. The difficulties of individual clerks, and
6. An analysis of inspection costs to determine if checking is worth the expense involved in terms of error prevention.

With the information provided by a clerical quality audit, management can in many cases eliminate sources of error or poor performance in addition to cutting inspection costs shown to be excessive.

The Quality Audit

The purpose of the quality audit is to provide management with three check points, as follows:

1. The current level of accuracy in a clerical operation producing a paperwork product.
2. The current costs of inspection and of verification.
3. An estimate of the costs of inspection and verification to maintain the proposed quality level.

With such data in hand, management is in a fairly good position to determine what quality control has to offer and whether it will pay to install it.

A quality audit consists of four basic steps for each clerical procedure to be analyzed in an organization.

1. **The Process Analysis**—the major work flow highlighting the way in which paperwork is created, processed, and maintained.
2. **The Frame**—the listing of all paperwork products within a selected period of time (e.g., invoices, vouchers, orders, etc.) whose quality is being audited.
3. **The Sample**—that portion of the frame (or total work) selected for detailed check.
4. **The Check**—the detailed review of the sample to determine the actual quality level (percent of errors or poor performance).

The Process Analysis

Since clerical operations vary, the process analysis is the first step taken to reveal the specific major paperwork procedures under study. The six basic purposes of the process analysis are to highlight:

1. Current costs of inspection and verification.
2. Cost of errors and poor performance.
3. Which operations might best be inspected.
4. What parts of the operation or of the training might tend to cause errors or poor performance.
5. At which steps samples of work should be taken.
6. The best alternatives in defining the population and the sampling unit (i.e., the frame) discussed below.

To accomplish these purposes, the process analysis should contain at least estimates (as accurate as the quick count and check will permit) of the following information:

1. Sections or departments engaged in repetitive paperwork operations.
2. A listing of these repetitive operations and the work flow involved in each.
3. Explanation of the work performed at key steps in the work flow.
4. An estimate of the work load and average rates of pay.
5. The number of employees in each operation.
6. At inspection or verification steps, the level (salary-wise) of employees (for cost consideration).
7. Paperwork products of the operations (e.g., files of orders, reports) and how long they are retained (e.g., 1952 to date).

Three types of forms will suffice to furnish this information systematically: an A card, a B card, and a C card. These cards will be discussed in connection with a hypothetical XYZ company. The A card merely lists the sections or departments to be further analyzed. For the XYZ company, it is the three departments which have heavy loads of repetitive paperwork operations, thus:

A

XYZ COMPANY

1. Central Filing
2. Accounting Section
3. Purchasing Section

The B card lists the clerical operations and personnel data in the sections named on the A card.

B cards for two of these departments are shown below, indicating the operations there plus some miscellaneous information:

B-1

CENTRAL FILING

1. Filing	6 regular clerks
2. Picking	5 level A—$40-$60 wk.
3. Incoming Requests	1 level C—$80-$100 wk.

B-2

ACCOUNTING SECTION

4. Accounts Payable	14 regular clerks
5. Credit Memos	
6. Invoices	

For each clerical operation a C card is prepared. Each C card should contain the information on work load, personnel, etc., which influences how the quality sample will be selected, checked, and interpreted.

C-1

FILING

About 500 units filed per day. No inspection except on new girls—then "spot" check; types of filed material—correspondence, checks, vouchers, orders, credits, advertising.

1. Mail boys bring in vouchers, orders, etc.
2. Miss S. sorts it out.
3. Gives out work to girls.
4. Girls file material.

Certain girls are responsible for certain files.

C-4

ACCOUNTS PAYABLE

Volume about 1,300 per month average load—2 clerks per day, but 10 different clerks do this type of work.

1. Incoming bills from suppliers are sent by departments to A/P through inter-office mail.
2. Clerk receives and prepares money total involving arithmetical calculations and taking discounts.
3. a. If in error, sent back to original department receiving.
   b. If correct, sent to typist who types up check.
4. Original clerk checks typing and initials.
5. Second clerk reviews (two reviews if over $2,000).
6. a. If correct, to voucher register clerk.
   b. If in error, back to original department.

C-7

VOUCHERING

One clerk, Level B, $60-$80; Frequency: 40 to 50 per week

1. Department sends in requisition (may be already purchased).
2. Miss R. checks departmental expenditures balance.
3. Sent to purchasing agent, Miss N.
4. Miss N. fills out purchase order.
5. Sent to typist; four copies made.
6. Two copies sent to vendor; one to original department; one on file here.
7. Vendor signs, returns one copy.
8. Sent to department to verify receipt.
9. Returned here and paid if verified.
10. Second copy also filed.

The Frame

The second basic step is to make a frame which lists all homogeneous paperwork units to be covered by the audit. For checking Accounts Payable, it would be a listing of all the vouchers; in Purchasing—all the purchase orders; in Personnel—all the employee history cards, etc., for the period (day, week, month or year) we are checking. The frame, therefore, is a list of all the work from which the sample will be taken. It is not necessary to list each piece of paperwork. A folder, booklet or file drawer are usually better definitions. They afford convenience in making the frame and selecting the sample.

Not all units listed are taken into the sample. But the whole population is covered so that each item is given a chance to appear in the sample. Any inference made from the latter is applicable only to the group of units listed. This procedure is enumerative, and does not refer to the "processes" under consideration. This restriction is necessitated by the facts that (1) this is a single preliminary sample survey and (2) many clerical operations do not have the properties of stochastic processes, as do their industrial counterparts.

Locating and defining all units in the frame helps to insure that a representative, random sample will be taken. A frame lists N units, from which a sample of size n is to be drawn.

The frame should include all work done for a period of time up to perhaps one or two years. Sometimes data for a period of that length are not available. The longest time period available should then be used, in which case the sample will indicate the accuracy only for that specific length of time.

Work in preparing the list can be simplified. Usually the items to be included in the audit can be divided into sampling units in a number of ways. For example, where the work being audited is maintained in folders, booklets or file drawers, the frame can list the folders rather than each piece of paper within the folders.

The best method of defining a frame is not always readily apparent. A large unit, while more convenient, generally leads to less precision. Smaller units offer a smaller variability, but often cost heavily as time consumers in the making of the frame. A general rule to follow is to try to avoid larger sampling units when it is believed that there will be a tendency for errors to cluster within specific ones. For example, in writing out orders, if clerks had their own folders, errors would tend to cluster in beginners' folders. Therefore, the folder should not be considered as a sampling unit.

The following exemplifies a frame defining a population of 59 folders, each containing about 100-200 purchasing orders. It assigns a serial number to each folder and locates them specifically.

EXAMPLE I

Drawer	Time Period	Folders	Cumulative
A	1/53–6/53	21	1–21
B	7/53–2/54	23	22–44
C	3/54–7/54	15	45–59

This is certainly easier than listing each one of about 9,000 purchase orders individually on the frame, and yields an operational definition of the population.

Not all frames are so easily defined. The following is more involved. It represents a population of file drawers containing 1953-54 material in a central file room. The frame is stratified by clerks since various workers were responsible for different files.

EXAMPLE II

Area	No. of Drawers	Contents	Cumulative	Worker	Worker Cumulative
A	63	Checks	63	R	63
C2	37	Checks	100	R	100
D	25	Cash Envelopes	125	R	125
D	19	Branch	144	R	144
F	24	F Division	168	R	168
G	7	Checks	175	R	175
G	10	H,C Divisions	185	R	185
B	32	S Orders	217	C	32
B	5	S Credits	222	C	37
B	3	C Orders	225	C	40
E	75	Vouchers	300	all	75
B	6	KG Credits	306	W	6
B	18	S Correspondence	324	W	24
B	13	S Advertising	337	W	37
B	2	S Ad Duplicate	339	W	39
B	1	Vendor Bills	340	W	40
B	12	S Miscellaneous	352	W	52
D	5	S Ad Survey	357	W	57
G	1	Requests–1954	358	W	58
G	1	Requests–1953	359	W	59
B	10	HJ Division	369	K	10
F	18	BV Orders	387	K	28
F	1	BV Credit	388	K	29
F	2	BV Correspondence	390	K	31
F	2	BV Miscellaneous	392	K	33
F	2	BV Correspondence	394	K	35
F	1	BV Credit	395	K	36
F	32	C Corr.–Vend.	427	K	68

Some frames must list the paperwork units themselves rather than the file drawer or folder. The following population of invoices is an example. Since invoices are consecutively numbered at the start, the frame listed the invoices by the five divisions which processed them and then broke the invoices down numerically within each of the five divisions.

EXAMPLE III

Year	Serial Numbers	Division	Units	Divisional Cumulative
1952	13001 -14500	C	1500	1500
1953	14501 -25500	C	11000	12500
1954	25501G-30249G	C	4749	17249
1952	501 - 1500	F	1000	1000
1953	1501 - 4000	F	2500	3500
1954	4001F- 4894F	F	894	4394
1952	12001 -13000	S	1000	1000
1953	13001 -26000	S	13000	14000
1954	26001T-32236T	S	6236	20236
1952		H-HJ	500	500
1953	3501 - 4000	H-HJ	4500	5000
1954	6001 -10500 10501R-12241R	H-HJ	1741	6741
1953	53001 -58500	BV	5500	5500
1954	58501P-65000	BV	6500	12000
			Total Cumulative	60620

In all these examples the population is so defined that a sample is easily drawn. Also, the units are meaningful. By carefully checking any of them, error and error rate information is apparent.

The Sample

There are two considerations involved in sample selection. First is size—"How many of the units listed in the frame should be selected and checked?" Second is the method—"Which units should be included in the sample, or how can representative units be selected?"

For the type of information necessary, the sample size should be based primarily on the level of accuracy that exists. The less accurate an operation is, the greater the need for a larger sample of units. The more accurate an operation is, the less the need for a larger sample of units. This principle involves 1) statistical concepts of variability and precision* that need not be discussed at length here, and 2) the fact that among less accurate operations, a more detailed analysis of errors is desirable.

Sample size also depends to a smaller extent on the number of units listed in the frame. The following formula is a convenient guide to be used for determining quickly the size of a sample (n) for a population of size N.

$$n = \frac{Ng}{N + g}$$

If we let e be the desired accuracy level (e.g., e = ± 0.01), and k the normal deviate (e.g., for 0.99 confidence k = 2.5758), g is defined by the equation

$$g = (k^2pq)/e^2,$$

where p is the expected ratio of incorrect units to total units, and $q = 1 - p$, the estimated accuracy.

The formula for n is obtained by eliminating σ_p from the following equations and then solving for n:

$$1)\ k\sigma_p = e$$

$$2)\ \sigma_p^2 = \left(\frac{N - n}{N}\right)\left(\frac{pq}{n}\right)$$

In these equations σ_p denotes the standard deviation of the observed error ratio in a sample of size n.

The values of g, for 99 percent confidence, can be determined from the table given below after a rough estimate of what the expected accuracy level is.

Estimated Accuracy	g
0.990	657
0.975	1618
0.950	3152
0.925	4603
0.900	5972
0.850	8460
0.800	10616

The g values shown provide a sample size that allows an estimate of the actual accuracy rate within 0.01 about 99 times in 100, provided all the sample units are selected at random, and the expected number of incorrect units in the sample is 25 or more so that the observed error ratios tend to be more or less normally distributed. The actual precision (which under various circumstances might be larger or smaller than 0.01) of course, must be computed after the results of the sample are known, and must be computed by the appropriate statistical formula which depends upon the type of sampling design utilized.

The accuracy level may be based on empirical experience, or it can be roughly estimated during the process analysis. For example, in simple alphabetical filing procedures, 0.99 is warranted. In more involved classified filing, 0.975 may be a reasonable guess. For order interpretation usually 0.90 is optimum.

For the frame of 59 purchase order folders (in Example I) containing about 9,000 paperwork units, the process analysis indicated a 0.975 level as the basis for sample size determination. Using the formula, $n = Ng/(N + g)$, we obtain

$$\frac{9000 \times 1600}{9000 + 1600} = 1358$$

as the number of paperwork units to be checked. As each folder contains about 150 orders, we would select 9 folders to be checked. Since the orders are selected by folders, and not individually, the observed accuracy level may differ from 0.975 by as much as 0.01 more than one percent of the time, even though the accuracy level in all the folders in the file is actually 0.975. The true variation can be determined only after the sample is drawn and the standard error estimated by the appropriate formula.

Another case is the listing of 427 file drawers in Example II. Since a rough estimate of an average drawer is 100 file units, N is equal to 42700. Using the proposed formula, we get

$$n = \frac{Ng}{N + g} = \frac{42700 \times 700}{42700 + 700} = 689.$$

Therefore, seven file drawers with about 700 pieces of correspondence is the convenient sample size. In this case, since the frame is stratified by workers into five groups, R, C, W, K, and all, the sample should be allocated among them. R with the largest share can get three units, all the others one.

Of primary importance in the method of selection is randomness. Since each member of the frame is assigned a serial number, it is convenient to use random numbers to pick sampling units. Such use insures each item an equal opportunity of appearing in the sample. In central filing, for example, it would be most convenient in checking not to select a sample from files near the floor or others inconveniently placed. However, clerks meet the same difficulties of discomfort in filing in these drawers and the error rates therein are likely to be higher. Non-random samples may distort the true picture.

Any of the following three plans will give a ten percent random sample:

1. With a random start, take every 10th unit in the frame (a systematic sample).
2. From every 10 units, select one at random (a patterned sample*).
3. From a group of N items, select n at random where n is 10 percent of N (a simple random sample).

The third method, n of N items, is used for the purchase order frame in the table below. In this example, however, n is about 15 percent of N, computed as nine sampling units in the preceding section. Nine random

*This refers to the fact that as p (the error ratio) increases from zero to 0.50, n must be increased for the precision, σ_p, to remain constant.

*This term is the writer's preference and is not in general use.

numbers between 1 and 59 resulted in the following nine folders falling into the sample:

	Random Number	Drawer	Folder (by date)
1.	23	B	7/21/53
2.	15	A	5/5/53
3.	5	A	2/4/53
4.	54	C	5/18/54
5.	14	A	4/28/53
6.	38	B	1/5/54
7.	31	B	10/20/53
8.	43	B	3/10/54
9.	49	C	4/6/54

A similar method for the stratified file drawer population gave the following 7-unit sample, which is a type of stratified sample:

	Clerk	Random Number	Drawer	Contents
1.	R	50	50	Checks
2.	R	165	165	F Division
3.	R	98	98	Checks
4.	C	20	205	S Orders
5.	all	35	260	Vouchers
6.	W	37	337	S Advertising
7.	K	49	408	C Corr.-Vend.

The Check

Each of the paperwork units that is drawn into the sample must be carefully checked by a verifier familiar with the operation. Such an inspector, perhaps one of the better regular clerks or a supervisor, is best able to ascertain quickly the nature and the cause of errors found.

The number of units, the number of errors, and the types or the sources of the errors should be compiled. At times it is desirable to list other pertinent information for use in the final evaluation of the operation. Such might include the division to which the paperwork applies, the clerks who made the errors, and/or the dates of the mistakes.

Results of a check applied to the sample of the nine folders of purchase orders is illustrated in part below:

(Folder #23—7/21/53)

Originating Division	Total Units	Errors	Accuracy Rate	Types of Errors						
				A	B	C	D	E	F	G
S	42	2	0.952	-	-	-	-	1	-	1
C	31	1	0.968	-	-	-	-	1	-	-
BV	33	3	0.909	-	1	2	-	-	-	-
F	57	1	0.982	-	-	-	-	1	-	-
H-HJ	18	0	1.000	-	-	-	-	-	-	-
KG	16	1	0.938	-	1	-	-	-	-	-
	197	8	0.959	0	2	2	0	3	0	1

(Folder #15—5/5/53)

Originating Division	Total Units	Errors	Accuracy Rate	Types of Errors						
				A	B	C	D	E	F	G
S	18	2	0.889	—	—	—	—	1	1	—
C	13	1	0.923	—	—	1	—	—	—	—
BV	9	0	1.000	—	—	—	—	—	—	—
F	20	0	1.000	—	—	—	—	—	—	—
H-HJ	7	0	1.000	—	—	—	—	—	—	—
KG	15	2	0.934	1	—	—	—	—	1	—
	82	5	0.939	1	0	1	0	1	2	0

(Folder #5—2/4/53)

S	29	2	0.931	1	—	—	—	—	—	1
C	11	0	1.000	—	—	—	—	—	—	—
BV	18	0	1.000	—	—	—	—	—	—	—
F	20	1	0.950	—	—	—	—	—	—	1
H-HJ	9	1	0.889	—	—	—	—	1	—	—
KG	18	0	1.000	—	—	—	—	—	—	—
	105	4	0.962	1	0	0	0	1	0	2

(Totals—Sample of 9 folders)

S	345	15	0.957	1	2	4	1	4	1	2
C	237	6	0.975	0	1	2	0	2	2	1
BV	254	11	0.957	1	2	3	0	2	2	1
F	372	8	0.978	0	2	2	0	1	0	3
H-HJ	119	4	0.966	0	0	0	1	2	0	1
KG	185	11	0.941	2	2	1	1	2	1	2
	1,512	55	0.964	4	9	12	3	13	4	10

The type of error columns refer to the following groupings:

A. Form error; that is, the purchase order is not made out properly by clerk-typist.

B. Typing error; all except dollar and cents amounts.

C. Incorrect itemizations by divisions.

D. Incorrect itemizations by vendors.

E. Incorrect pricing of items by divisions.

F. Incorrect pricing of items by vendors.

G. Calculations in error by clerk-typist.

The accuracy rate for the total sample is computed as 0.964 ± 0.008*. This means that for the total population it can be said with 99 percent confidence that the level of accuracy is between 0.956 and 0.972.

Interpreting Results

As was earlier noted, the purpose of a quality check-audit is to provide four indices:

1. The current level of accuracy.
2. The current costs of inspection.
3. A tentative proposed level of accuracy.
4. An estimate of the costs related to the proposed level of accuracy.

Consider the purchase vouchering operation as an example. The check indicated an accuracy level at 0.964. The process analysis showed no formal check. The current values therefore are:

Accuracy	Checking Cost
0.964	$ 0

The problem is then to determine if the level of accuracy can be raised without incurring excessive expense. The answer is yes, if certain types of errors recur. In the vouchering example divisional errors are prevalent. Experience tells us quality control reduces the frequency of occurrence of these types of errors.

Continuous quality analysis would serve well in this case. A sample check of vouchers with error analyses could be expected to eliminate almost all divisional errors of these types. In addition a ten percent check on the calculations and typing involved would also cut the error rate. These facts are known on the basis of the suggested sampling plans.

These two procedural adjustments would involve no more than $10 a week in manpower. The error rate eventually should be reduced at least 75 percent, within three months. The proposed values are therefore:

Accuracy	Checking Cost
0.990	$10 a week for 3 months

*As noted earlier the variability must be based on data from the sample itself, and cannot be taken simply as 0.01. In this case both the accuracy rate and the precision of it are based on formulas for cluster sampling. (See, for example, William G. Cochran, *Sampling Techniques*, New York: Wiley and Sons, p. 203-205.)

The Decision

Is such a gain worthwhile? Should advantage be taken of it? This is a decision for management. It is almost always impossible to reduce everything to a numerical base. The cost of errors cannot be completely measured in dollars and cents. Some factors are intangible—good will, worker morale, outside companies' time, etc. It also should be mentioned that it is difficult to determine in advance the exact level of quality to be expected. Generally, a good indication can be gotten from the quality audit. And as quality control develops, greater gains can usually be expected. In any event the quality audit will aid in a decision management must make.

The Quality Audit Report

With the following type of table, management can quickly determine which areas will show a profit from quality control applications:

	Accuracy		Cost per Week		
	Current	Proposed	Current	Proposed	Estimates
1. Invoicing	0.942	0.985	$ 65	$ 65	Gain: 224 less errors per year at no added cost.
2. Accounts Payable	0.990	0.990	$140	$ 70	Gain: equal accuracy with yearly savings of $3,640.
3. Vouchering Payable	0.964	0.990	$ 0	$10 for three months	Gain: 270 less errors per year at a cost of $130.
4. Central Filing	0.988	0.991	$ 0	$ 20	Gain: 100 less errors per year at a cost of $1,040.

These four examples clearly point to four types of results that may arise from a quality audit:

1. Invoicing: quality control for gains in quality without an increase in inspection costs.
2. Accounts Payable: a decrease in inspection costs, but no gain in quality.
3. Vouchering: part time quality control for permanent gains in accuracy.
4. Central Filing: small gains, which involve excessive expense.

The continuing use of quality control may have an optimum time period. When the error rate ceases to diminish, routine sample inspection may be unnecessary for a period of time. However, after a cut-back in the amount of inspecting, occasional quality audits will serve to indicate whether accuracy levels are being maintained, and whether quality control should or should not be reinstalled.

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Inductive Accounting

Settling Interline Accounts by Sampling Methods

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Introduction

The quality control application which is discussed in this article relates to the use of statistical sampling in the settlement of interline accounts between air carriers. This application is specifically entitled, "Inductive Accounting." It is essentially the substitution of a statistical sample for a 100 percent accounting operation and thus it differs from the popular applications of quality control in the areas of inspection and clerical verification. In other words, inductive accounting is not a sample or a test of an accounting operation, but rather, is the use of a sample as the basis for establishing accounting payments.

The inductive accounting application is not entirely an original idea and the solution is not unique. It does demonstrate, however, some

work in a relatively unplowed area for the uses of statistical sampling. The significant factor in the development of this application is the reliance which accounting people place on the inductive accounting method and their willingness to settle accounts based on the results of sample information. This is an important departure from conventional accounting practice which opens the door for many similar applications in other accounting areas.

It should be noted at the outset that the idea for inductive accounting originated with accounting people. Their problems in handling the large volume clerical operations necessary to establish interline billings were growing steadily. They knew of quality control successes in auditing and clerical verification. It was quite natural, therefore, to hope that statistical sampling might be applied directly to the interline accounting problem, thereby reducing clerical workload. They did not know if, or how, this could be done. They *did* know what their required accuracy would be and the risk levels they could assume. And, of course, they knew they could bring their problems to quality control people for discussion and study. The application of statistical sampling techniques to this problem has resulted in the inductive accounting method.

In pursuit of this problem, United, Trans-World, and Northwest Air Lines agreed to study the problem in detail. The study was begun over three years ago. The above carriers conducted extensive research during this period.

On February 1, 1956, the inductive accounting method was installed as the basis for settling their interline accounts. Other carriers will begin to participate in this program as soon as their specific statistical requirements are determined. Individual clerical savings based on this application could be as much as $100,000 annually for particular carriers. For the industry, savings could amount to more than a half million dollars annually. And this is just in the interline accounting area. There is equal or greater potential in other accounting areas.

The Interline Billing Situation

Before discussing the inductive accounting method specifically, the description of a typical interline route will be helpful to define the problem. Figure 1 outlines a typical interline travel situation.

The diagram shows the travel route of a passenger who wishes to go from Portland to Seattle to Chicago to New York. The important feature of this travel situation is that UAL will sell the complete ticket to the passenger and collect the entire fare for the travel indicated. United, however, will carry the passenger only from Portland to Seattle. As indicated, Northwest will perform the travel from Seattle to Chicago, and TWA from Chicago to New York. In order for NWA and TWA to collect revenue for travel performed, they must each pro-rate the total indicated fare of $158.85 for that portion of travel which they performed. Pro-rating the total fare is done in accordance with airline tariff regulations. This pro-rating, or pricing as it is usually called, is a complex, time-consuming and costly clerical operation. It is for the purpose of reducing this pricing workload that the inductive accounting method is employed.

In the above situation, it should be noted that the passenger traveling the indicated interline route received a ticket with three coupons. Each coupon is lifted or collected by the carrier performing travel over the segment indicated. This coupon is the basis for revenue settlement. In the example above, it is the basis on which NWA and TWA collect from United. For example, the travel portion from Seattle to Chicago is pro-rated by NWA to be $105.63 and UAL will be billed accordingly.

In order to clarify terms, it should be pointed out that a *ticket* comprises all the coupons involved in a passenger's travel itinerary. A *coupon* is the single portion of the ticket representing one segment of the itinerary, e.g., Chicago-New York. In those cases where an itinerary involves only one segment of travel the terms "ticket" and "coupon" have synonomous meanings.

The Sampling Problem

Interline travel and the interline coupon have been defined. The need for interline billings has been described. Understanding of the sampling problem involved will require a further examination of the physical and statistical characteristics of the interline accounting operation.

A. *The Sampling Unit*

In developing a sampling plan, the coupon is the basic sampling unit. The coupon contains the information required to develop the pro-rated dollar value. Specifically, the ticket contains the following:

1. The origin and destination which is the basis for determining mileage. For example, the standard mileage between Seattle and Chicago is 1,734 miles.
2. The total fare which is the dollar basis from which the pro-rate for individual coupons is made.
3. The type of travel performed. For example, first class one-way, half-fare, coach, military, etc.
4. The coupon number, a serial number which distinguishes each coupon from every other coupon.

These basic elements in each coupon provide the framework for a sampling method. The coupon is the primary sampling unit. Fare and miles are the basic variables. The pro-rated fare is the actual dollar value of each ticket coupon.

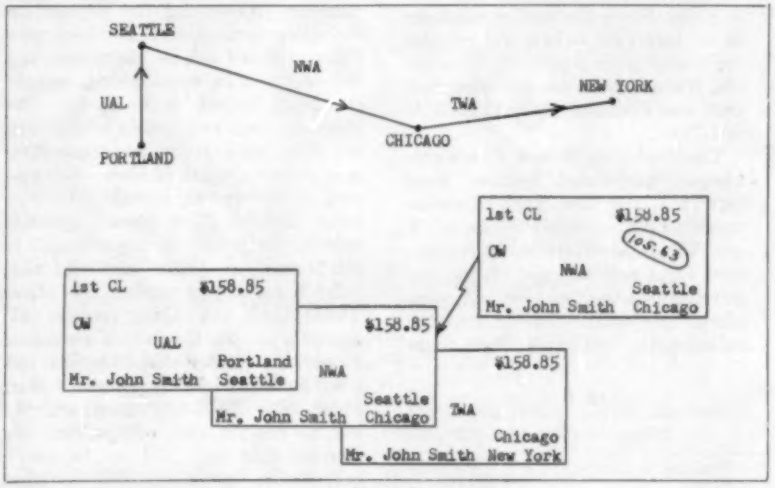

Figure 1

Type of service classification will provide the means for necessary stratification. The coupon number is the basis for random selection and control.

B. *The Population*

The population in the interline problem is defined as the total number of coupons lifted by the billing carrier during one month which was sold by the billed carrier. For example, if, in the month of June, 20,000 passengers had bought tickets from TWA but used United Air Lines' service, United would have lifted 20,000 coupons. This batch of coupons is the basis for billing TWA for travel performed. It is the population for purposes of sampling. Table I shows the data for a typical population.

In this typical case UAL has lifted 20,000 tickets which are valued at $645,885 (after pricing) and will bill TWA for this amount. The conventional method for determining this total dollar billing is to price each of the 20,000 coupons and summarize the individual prices. In order to eliminate most of the laborious clerical work involved in this pricing activity, a small sample of the 20,000 coupons can be priced and an acceptably reliable estimate of the $645,885 total value can be made.

C. *The Statistical Problem*

The sampling method used in the inductive accounting application employs the regression estimate. As shown earlier, the sampling unit is the ticket coupon and the basic variables are the fare and the miles on each coupon. For later reference, X = fare and Y = miles. From the earlier example of an interline ticket, the coupon for travel from Seattle to Chicago via NWA would be the sampling unit and contains X = $105.63, Y = 1,734.

The variables, X and Y, are obviously correlated because total fare will increase with distance traveled. The relationship of X and Y can be expressed in regression form and the use of this relationship is the most refined sampling approach. The regression relationship indicates that there

TABLE I

UAL Billings to TWA, June 1956

Coupons	20,000
Miles	12,471,000
Fare	$645,885

TABLE II

UAL Billing to TWA, June 1956

Strata	X Fare	Y Miles	N Coupons	S_1	r
1. First Class-Full Fare	$310,930	5,015,000	8,500	4.00	0.98
2. Military	121,055	2,201,000	3,100	3.00	0.97
3. Coach	168,750	3,750,000	6,250	2.00	0.95
4. First Class-Half Fare	45,150	1,505,000	2,150	3.50	0.97
Total	$645,885	12,471,000	20,000		

are definite patterns for different types of service. These differences between the four types of service provide a logical basis for stratification which will introduce further efficiency in sampling. The population data from Table I are shown in Table II with stratified groupings indicated.

The correlation coefficient (r) between X and Y and the standard error of estimate (S_1) of the fare per coupon about the regression line indicate that a sampling approach to the interline accounting problem is both feasible and practical. Typical values for these two statistics are shown by strata in Table II in which the r values are high and S_1 values are relatively small. This indicates a very close fitting pattern and a small sample error. Furthermore, r and S_1 tend to remain stable from month to month. The glossary and formulae which relate to the specific definition and use of r and S_1 in estimating interline billing are set forth in the appendix.

The final factor of importance in implementing a sampling application in the settlement of interline accounts is the consideration of precision requirements and risk levels for the sampling plan. It is recognized that in estimating billings each month, sampling error exists. The only way to avoid this is to price all coupons. Accepting the population definition and statistical characteristics outlined above, the remaining requirement in establishing sample size each month is to specify the precision and risk levels which will be acceptable from an accounting and auditing point of view. For example, in typical monthly billings from UAL to TWA for a particular month, the precision requirement is established at $1,500 and the risk level is set at five percent. In other words, UAL, the billing carrier, will accept a sample size which assures a 95 percent chance that they will not under-bill TWA by more than $1,500. For TWA this means accepting the results with a 95 percent assurance that they will not be overbilled more than $1,500. For the plan this represents a 90 percent confidence band, for each carrier a 95 percent confidence level.

Procedure

The previous section was devoted to a brief discussion of problem definition and the statistical aspects of inductive accounting. In this section, the steps in the sampling plan each month are outlined. The outline, in effect, represents the set of rules which each carrier follows in implementing the sampling method. Further, the outline assumes the basic definitions and statistical characteristics described previously. Necessary formulas and the random selection procedure are detailed in the appendix. This sampling procedure falls into two categories: (a) steps 1-5 involve the determination of optimum sample sizes based on estimates of N_1, S_1 and r; (b) steps 6-12 comprise actual drawing of the sample, analysis and evaluation of sample data, and finally the processing of the billing invoice.

A. *Computation of Optimum Sample Size*

Step 1—Determine the requirements of dollar precision and risk. Once determined these factors usually remain constant from month to month.

Step 2—Estimate coupon volume (N) by stratum for each carrier involved in the inductive accounting procedure. This step is required to determine the estimated sample proportion which, in turn, is necessary to determine which level in the random sampling table will be used. (See step 5 below.)

Step 3—Estimate the standard error (S_1) of the fare per coupon for each stratum. These estimates are based on the results of previous samples.

Step 4—Compute the optimum sample size (n) for total population and for each stratum.

Upon the completion of steps 1 through 4 the results are sent to the carrier to be billed in the form of a letter of specification. These

specifications are, in effect, a statement of the amount of sampling to be done for an expected standard error and specified precision and confidence levels. If the carrier to be billed does not accept the sample size or the precision and risk requirements, these will be negotiated before actual sampling is begun.

Step 5—Compute n/N to determine the sample proportion.

B. *The Sampling Operation*

Step 6—Refer to Table III (see the appendix) to determine which coupons will be sampled and select the sample accordingly.

Step 7—Price the coupons in the sample.

Step 8—Process the sample coupons through IBM to obtain data necessary for analysis purposes.

Step 9—Compute actual S_t and determine N from sample analysis results. Recompute sample size requirements to determine if specifications of precision and risks were satisfied.

Step 10—If results are acceptable, estimate total billing (DB) and prepare invoice for billing.

Step 11—If results are not acceptable, draw additional sample from "reserve sample", price, and repeat Step 8.

Step 12—The billed carrier will audit sample results only for (a) pricing errors, (b) sampling procedural errors, and (c) computational errors. Any disagreement at this stage will be resolved jointly before the interline billing is paid.

Conclusion

The inductive accounting method, as outlined above, has been given careful and extensive tests. During a six month period prior to February 1, 1956 the proposed sampling method was performed simultaneously with the 100 percent accounting operation. This provided a comparison between the sample results and the actual billing accumulation. The test was made for two reasons. First, to verify the details of sampling method and analysis. Second, to demonstrate that the sampling plan would work and produce the desired precision. The latter purpose was primarily to demonstrate the reliability and predictability of statistical sampling. When it is considered that the inductive accounting method is a substitute for the more conventional accounting method and is the basis for settling dollar accounts, it is understandable that its reliability must first have been clearly demonstrated to those who do not have statistical training.

With the development of this method for interline settlements, it is expected that similar techniques will be employed in other accounting areas where the burden of paper work and the volume of clerical operation is growing. The inductive accounting method is just a beginning. Statistical sampling can be employed with equal success in the many areas where large volume accounting and paper work problems exist.

TABLE III—Table of Selected Digits for Use in Random Sampling

(1) When Required Sample Proportion (n/N) 100 Equals	(2) Gross Sample Draw All Tickets Ending In	Separate Tickets Drawn in Column (2)	
		(3) *Required Sample* Price All Tickets Ending In	(4) *Reserve Sample* Balance of Tickets for Additional Sample If Necessary
6%	0 1	10 20 30 40 50 60	00 70 to 90 & 01 to 91 14%
7%	0 1	10 20 30 40 50 60 70	00 80 to 90 & 01 to 91 13%
8%	0 1	10 20 30 40 50 60 70 80	00 90 & 01 to 91 12%
9%	0 1	10 20 30 40 50 60 70 80 90	00 01 to 91 11%
10%	0 1	1	00 10 to 90 10%
11%	0 1	1 10	00 20 to 90 9%
12%	0 1	1 10 20	00 30 to 90 8%
13%	0 1	1 10 20 30	00 40 to 90 7%
14%	0 1	1 10 20 30 40	00 50 to 90 6%
15%	0 1	1 10 20 30 40 50	00 60 to 90 5%
16%	0 1 2	1 10 20 30 40 50 60	00 70 to 90 & 02 to 92 14%
17%	0 1 2	1 10 20 30 40 50 60 70	00 80 to 90 & 02 to 92 13%
18%	0 1 2	1 10 20 30 40 50 60 70 80	00 90 & 02 to 92 12%
19%	0 1 2	1 10 20 30 40 50 60 70 80 90	00 02 to 92 11%
20%	0 1 2	1 2	00 10 to 90 10%
21%	0 1 2	1 2 10	00 20 to 90 9%
22%	0 1 2	1 2 10 20	00 30 to 90 8%
23%	0 1 2	1 2 10 20 30	00 40 to 90 7%
24%	0 1 2	1 2 10 20 30 40	00 50 to 90 6%
25%	0 1 2	1 2 10 20 30 40 50	00 60 to 90 5%
26%	0 1 2	1 2 10 20 30 40 50 60	00 70 to 90 4%
27%	0 1 2	1 2 10 20 30 40 50 60 70	00 80 to 90 3%
28%	0 1 2 3	1 2 10 20 30 40 50 60 70 80	00 90 & 03 to 93 12%
29%	0 1 2 3	1 2 10 20 30 40 50 60 70 80 90	00 03 to 93 11%
30%	0 1 2 3	1 2 3	00 10 to 90 10%

Note: This table can be extended to include any required sample proportion.

Appendix

A. *Glossary*

X = Fare.

Y = Miles.

N = Total actual coupons in stratum. The actual data are obtained by machine count.

n = Actual sample from each stratum.

M = Total actual miles in each stratum. The actual data are obtained by machine count.

S_t = Standard error of estimate of fare-per-coupon, about the regression line in each stratum.

D = The allowable total dollar risk for all stratum combined.

DB = Estimated total dollar billing based on sample data.

DV = Estimated dollar variance for the stratum.

k = Normal deviate. For 5 percent underbilling risk level, k = 1.65.

r = Correlation between fare and miles.

f = n/N.

B. *Formulae*

For determination of sample size based on population estimates

1. Minimum sample size for the population

$$n' = \frac{(\Sigma\, N'_i\, S'_i)^2}{(D/k)^2 + \Sigma\, N'_i\, (S'_i)^2}$$

2. Optimum sample size for each stratum

$$n'_i = \frac{N'_i\, S'_i}{\Sigma\, N'_i\, S'_i}\, n'$$

For computation based on actual sample data

3. Estimate of stratum total dollar billing

$$DB = \frac{N}{n}\Sigma X + \frac{n\Sigma XY - (\Sigma X)(\Sigma Y)}{n\Sigma Y^2 - (\Sigma Y)^2}\left(M - \frac{N}{n}\Sigma Y\right)$$

4. Estimate of stratum dollar variance

$$DV = \frac{(1-r^2)N^2(1-f)[n\Sigma X^2-(\Sigma X)^2]}{n^2(n-1)}$$

5. Standard error of estimate of fare-per-coupon

$$S_i = \sqrt{\frac{(1-r^2)[n\Sigma X^2-(\Sigma X)^2]}{n(n-1)}}$$

6. Formula for r^2:

$$r^2 = \frac{[n\Sigma XY-(\Sigma X)(\Sigma Y)]^2}{[n\Sigma X^2-(\Sigma X)^2][n\Sigma Y^2-(\Sigma Y)^2]}$$

References

Deming, W. E., *Some Theory of Sampling*, John Wiley & Sons, Inc.

Hansen, M. H., Hurwitz, W. H., and Madow, W. G., *Sample Survey Methods and Theory*, John Wiley & Sons, Inc.

C. *Random Selection Procedure*

The basis for random selection is the six digit coupon number. The last two digits of this coupon number are sufficiently random for this purpose. Table III is a schedule of random numbers which has been set up for use by all carriers in drawing random samples. This table has two purposes. First, to provide a standard pattern of random selection for each carrier to follow. Second, to make the rules of random selection as simple and uniform as possible for the clerical personnel involved.

By estimating the expected number of coupons in each stratum, the carrier can determine the estimated sample proportion required for each stratum. Entering the random number table for that proportion the specific random digits or paired digits can be found. This provides at the beginning of the month the specific digits necessary to draw the samples. As indicated in Table III, the total sample is divided into the "required sample" and the "reserve sample". It is necessary to provide for a reserve sample because once the coupons leave the Revenue Accounting Department and are processed by machine accounting and batched, it is very difficult to draw additional samples. Hence the reserve sample provides a readily available cushion should additional sampling be necessary.

Local Section News

"... BUT NOT FORGOTTEN"

ALBUQUERQUE At the regular meeting of Oct. 8 Harold F. Dodge, winner of the 1950 Shewhart Medal, addressed a large audience of members augmented by numerous visitors on the subject of continuous sampling plans. Mr. Dodge employed a new demonstration device to illustrate the operation of continuous sampling.

Preceding the regular meeting, John M. Wiesen, Sandia Corp., reviewed a paper by Herbert C. Batson of the University of Illinois entitled "Applications of factorial χ^2 to experiments in chemistry," published in the ASQC National Convention Transactions, 1956.

ALLENTOWN-BETHLEHEM The Oct. 10 meeting filled the Blue Room of Walp's Restaurant to overflowing. Dorian Shainin, industrial consultant and prominent speaker in the field of SQC, made the principal address of the evening on "Breaking through industrial problem barriers." Well-sprinkled with examples taken from his own experiences, Mr. Shainin's talk emphasized that many problems, previously regarded as insolvable, actually yielded to an attack organized upon the principles of statistical quality control.

BALTIMORE The section had its first meeting of the 1956-57 year on Oct. 17 at Johns Hopkins University. F. J. Cullen spoke on the subject "Organizing, selling, and operation of a QC program in the plastics industry." Approximately 50 members and guests were present.

BINGHAMTON Our October meeting was held in the Endicott American Legion and a fine steak dinner was enjoyed by all who attended. The speaker of the evening was Mr. Harrington, chief engineer of the DoALL Co.; the subject, "Principles and techniques in precision measurement." Mr. Harrington's talk was excellent and thoroughly enjoyed by all those present.

This year the section is presenting a certificate of membership to all members who have renewed their membership before Nov. 1, 1956. For members who have been in the Society for at least five years, the certificate will be framed.

BOSTON The 10th New England QC Conference in Springfield was one of the most successful to date. M. W. Rogers, assisted by Mrs. Rogers, ably handled the large registration. Warren Purcell of Boston was the keynote speaker. An innovation was a lecture by Charlie Hudson for wives of registrants which served as an introduction to QC ideas.

BUFFALO Sixty-five members of the section visited the Buffalo Tube Plant of the General Electric Co. on Oct. 29. The group inspected the various manufacturing processes at the plant which is engaged in the production of television picture tubes. H. J. Elias, manager of quality control at the plant, and his staff hosted the quality control group. (The above picture shows Mr. Elias talking to several of the members during one phase of the tour. Standing left to right: V. Shelburne, Spencer-Kellogg; R. Bingham, Carborundum; N. Hodge, Great Lakes Carbon Corp.; W. Kubisty, Inspector of Naval Material; W. Toporczyk, American Machine and Foundry; A. Haven, Trico Products.) Prior to the tour he gave a talk on the various phases of quality control picture tube manufacturing. Following the program, a question and answer period was held. Refreshments were served.

Recently the Buffalo section received from Mr. N. Philpot, project manager, Industrial Training Div., International Cooperation Administration, Washington, D. C., a Certificate of Cooperation for arranging a plant trip in June through Carborundum Co., Niagara Falls, N. Y. This group was interested in statistical quality control in action and came to this country from Europe under the industrial resources training program. This program is designed to train teachers in the field of SQC. The group consisted of the following delegates: Charles S. Smith, England; Hans K. Brons, Denmark; Jaime da Cruz C. Ferrerra, Portugal; Alf R. Heimes, Norway; Kane L. Lauritzen, Norway; Kurt Stange, Germany; and Maren L. Wijvekate.

BURLINGTON In place of a September meeting, several members of the section participated in the very successful 10th New England Conference. W. W. Spencer was program chairman. Dan Lundvall, Chet Gadzinski, George Wood, and William Felton were speakers. Howard Halpin, Bob Martel, and Carlton Murphy acted as moderators.

BUZZARDS BAY Robert M. Hofstead of the Bristol Laboratories in Syracuse, New York was the main speaker at the Oct. 9 meeting. His subject was "Statistical quality control in manufacturing." A dinner for the speaker at the New Bedford Hotel preceded the meeting. Mr. Hofstead's illustrated lecture covered the mechanical industries. He outlined control methods of quality maintenance in research, development, and production of antihistamines where quality cannot be geared to economic considerations, but must be obtainable under all economic circumstances.

CHICAGO On the island of Hawaii, where only 1/10th of the area is suitable for cultivation, pineapple growing and canning is one of the outstanding industries. Carl Farden, of the Pineapple Research Institute, summarized at a Sept. 26 meeting of the section the activities of the industry and the services rendered by the Institute. Large scale agricultural experimentation is carried out, based on R. A. Fisher's work in planning of designs. Randomized blocks have been found to provide some of the most satisfactory arrangements.

At a board meeting, also held in September, the directors of the section discussed the details of the 1956-57 budget, reviewed the vigorous program developed by the membership committee, as well as incentives set up for sections to obtain new IQC advertisers. The meeting was attended by 15 members under the chairmanship of R. E. Tenney.

The advanced educational series consisting of 16 weekly meetings began on Oct. 2.

CINCINNATI On Oct. 17 the section held an interesting meeting with another fine attendance. A large crowd greeted Mr. Krause of the Procter and Gamble Co. who gave the coffee talk. Dr. Frank Wilcoxen's excellent talk drew forth many interesting questions from an attentive audience. In line with Chairman Birch's suggestion, a few members of the executive committee each meeting will explain the various duties of section committee members. Bill Barker, Mel Snow, and Don Brandt gave a synopsis of their individual duties.

The Hamilton-Middletown subsection held their October meeting at the Gardner Board and Carton Co. in Middletown. Gordon Thompson, vice chairman, reports

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that the initial effort to spread the gospel via an introductory SQC class is off to a bang with a total registration of 134 members.

DuWayne Carlson, quality control director for Gardner Board and Carton Co., acted as host and speaker for the evening. The subject of Mr. Carlson's interesting and informative talk was "Accumulative fraction defective control charts."

CLEVELAND Over 200 persons attended the third annual conference on Oct. 25. Comments indicated that the program was well received and the conference was quite successful. Many fine speakers, including Dale Lobsinger, were heard during the one day meeting.

Paul A. Robert was the speaker at the regular monthly meeting held on Oct. 5. His subject was "Vendor certification."

COLUMBUS Our Oct. 17 meeting was held at Jeffrey Mfg. Co. A very interesting talk on "Quality incentives" was presented by Richard Butler, industrial engineer for Kimble Glass Co. Mr. Butler gave us a practical method of pro-rating processes of various quality levels into a production incentive plan. The extended question and answer period that followed the talk was ample proof that it was interesting and well absorbed by the group attending.

Interest in our recent advanced course in "Acceptance sampling" was so great that we are planning another advanced course in some other phase of quality control. Watch for dates.

CORNING -ELMIRA Oct. 17 found 54 members and guests meeting at the Langwell Hotel in Elmira to hear Leo J. Jacobson, chief engineer for the International Resistance Co., Philadelphia, Pa., speak on "Process capability considerations in product and process design."

Final plans were announced for the first part of the section's educational program, which started on Oct. 31 at the Westinghouse plant in Horseheads. More than 70 persons attended. Instructors for the course, entitled "Elementary statistical analysis," are Professors H. K. Kao and Robert E. Bechofer of Cornell University.

DALLAS -FORT WORTH The attendance at the classes on "New concepts in quality control" which began on Oct. 2 was evidence of the interest in the more advanced techniques of design of an experiment, analysis of variance, correlation analysis, and tests for significance. Five instructors, (Dr. A. W. Wortham and Dan McKown from Chance Vought, Dave Gaylor and Jim Wallier from Convair, and Dr. John L. Wortham from Texas Christian University) have taken on the task of exposing the specialized techniques to the technical men from the industries in the area. One student in particular has a 200 mile trip to make for the weekly class. The purpose of the class is not to train the men in the application of the techniques but to expose them to the possibilities of solving industrial quality problems and to encourage the enlistment of qualified statistical engineers in solving these knotty problems.

DANVILLE -SUNBURY The regular monthly meeting was held at the Visual Aids Auditorium, Bucknell University, Lewisburg, Pa. on Oct. 19. The main address was given by J. Bemesderfer, a quality engineering specialist from the General Electric Co. in Cincinnati, who spoke on the topic of "Make it right the first time." Emphasis was stressed on the sales aspects of quality control and scientific methods in locating sources of defects.

The meeting was largely attended by members and invited guests from industries located in Danville, Sunbury, Milton, Montoursville, Williamsport, Bloomsburg, and Shamokin.

Plans are being formulated to conduct a QC course at Bucknell University this fall. Further information on this will be disseminated when available.

DAYTON The second regularly scheduled meeting for the season was held Oct. 11 at the Dayton Air Force Depot. This meeting was in the form of a luncheon and afternoon plant tour. Following the luncheon an interesting talk on quality control at the depot, as well as the function and growth over the last few years, was presented by Brig. Gen. L. G. Mulzer, the Commanding General of the Dayton Air Force Depot. Following his talk, the meeting was turned over to D. L. Kear who had arranged an interesting tour of the installation. This entailed a tour through the maintenance and repair section for electronic equipment, the manufacturing of radio crystals, the USAF Standards Branch, and a Univac installation. The application of QC to the repair and maintenance section was unique as compared to commercial production applications.

DELAWARE On Oct. 4 the section opened the 1956-57 season with its annual ladies night. Following a social period and an excellent dinner, about 50 members, guests, and their wives saw a color film "Quality control in merchandizing" which proved to be of particular interest to the ladies. This film shows the many and varied inspections and tests conducted on articles of clothing and household textiles in order to maintain the quality of these products at a level to insure the maximum of customer satisfaction.

A change occurred in the subject matter for our Dec. 6 meeting after publication of the November issue. The talk by Meredith E. Smith of the Du Pont Co. on the subject "New developments in replacement and failure analysis" was not presented. Instead Mr. Smith talked on the subject "Some practical applications of queuing theory."

ERIE On Oct. 18 we held our "opener" with a plant visitation to the Erie Works of the General Electric Co. After a splendid swiss steak dinner as the guests of GE at their community center, we were welcomed by Bertram Miller, works manager. A panel of speakers then presented a good view of QC at Erie GE. Al Breed of the L&E Div. discussed "Organization of QC in the L&E Div." which concerned the QC function in the management structure. Paul Green of the Erie Works Foundry gave a presentation with slides concerning "The use of $\bar{p}$ charts in a foundry." Don Broderick, room air conditioners, touched on the goes-in-tos of "Quality air conditioning." Klas Bol of DC motors spoke on "Education towards quality control in DC motors." Before touring the room air conditioning division the group saw the grand GE produced movie "This is automation." During the tour of the manufacturing area of room air conditioning, we had an opportunity to see various tests and inspections by which quality is maintained. The turnout for this meeting was the largest in the section's history for an opening meeting. This unfortunately was announced as a joint meeting with the Cleveland section. The committee in charge was unable to make proper arrangements to advise the Cleveland group on time. If the Cleveland section is willing we'll try again next season and get an earlier start.

GEORGIA At the regular meeting on Oct. 30 the Atlanta Group enjoyed a talk by Francis C. McLaughlin of the quality control engineering service of the General Electric Co., Schenectady, N. Y., on the subject "Programming the quality control engineering job." By actual experiences he pointed out the breadth of the opportunity for the quality control engineer and brought out considerable discussion.

GRAND RAPIDS The first dinner meeting of the season held in the Federal Grill was attended by 52 members and guests. Leon Bass, quality control manager of the Jet Engine Div., General Electric Co., Cincinnati and vice president of the Society, was the main speaker. Mr. Bass' topic for the evening, "Make it right the first time," followed by a question and discussion period was received with great interest.

GREATER MUSKEGON Thirty-eight members and guests were present at the section meeting in October to hear Vincent A. Nichols, superintendent of QC, aircraft section, Bendix Corp., South Bend, Ind. Mr. Nichols' topic was "Designing quality control applications to the personality of the operation." A film presentation, "Thundermakers," a story of jet engines, completed the evening's program.

HARRISBURG The first meeting of the new year was held at the RCA plant in Lancaster on Oct. 5. A tour of the color TV facilities proved most interesting to those attending. About 80 people attended the meeting and heard a very interesting discussion by George Scheel of the Sonotone Corp. on "The control of solder joint quality." This was the best start the section has had in a number of years and it looks as though we are off to the start of our best year.

KANSAS CITY The rescheduled October meeting was held on the night of the 18th. Preceding the dinner Ed Goodwin, Bendix, and Jay Rumberger, Westinghouse, led a group discussion on "The functions of a gage control group" as another phase of the season's quality control clinic. After dinner, John Cobb of Standard Oil presented the subject "Quality control in the petroleum industry." This meeting, falling during "oil progress week," made his presentation even more appropriate.

LINCOLN The second meeting of the 56-57 season was held at the Omaha Production Co. Following a tour of the plant, for the purpose of observing methods of SQC being employed, an enjoyable dinner was provided by the company. The featured speaker at the meeting following the dinner was D. Fretton of the Omaha Production Co.

LOS ANGELES The October meeting discussed "The role of reliability in the quality control function." This was the first of two joint sessions to be held with the IRE Professional Group on Reliability and QC. In the clinic and ensuing discussion, it was brought out that percent reliability is the percent of the items that function properly for a specified length of time. The vendor must often take the initiative in clarifying for a customer the necessity—and added cost—of a given amount of reliability. But certain types of failures are due to defect in engineering and production, not QC. There is need for better communication between QC personnel and reliability engineers, especially in drawing up of specs, and for more clear-cut delineation of authority and responsibility. The clinic was led by Wm. Urlovic, and the panel composed of L. W. Ball, E. C. Bennet, P. E. Fleury, and D. A. Hill.

LOUISVILLE The management night meeting held Oct. 8 at Schenley Distillers was the best attended meeting on this subject that we have ever had. Ninety-six persons had dinner together and then heard R. L. Gruenwald speak on "Improving quality control through personnel performance appraisals." Mr. Gruenwald, who is associated with General Electric Co. in Cincinnati, illustrated the pyramiding effect of responsibility—a responsibility which begins with the machine operator.

MEMPHIS The October meeting was held in the Community Room of the Leader Federal Savings and Loan Association, Oct. 30. The speaker was W. P. Drews of the Esso Standard Oil Co., Bayway, N. J., who spoke on the topic "Strategy in research." He demonstrated an electrical instrument for the analysis of experiments involving several variables and illustrated its use in a typical problem. Motion picture films taken at the meeting were shown on WMC-TV, Memphis, on Oct. 31.

METROPOLITAN The experimental afternoon-evening meeting held Oct. 10 at the Newark, N. J. YMCA proved a most satisfactory venture. Attendance at both the afternoon dinner and evening sessions was approximately 60. All of those in attendance enjoyed the talks by Frank Wehrfritz and Enoch Ferrell.

Perhaps the most desirable part of this type of meeting is the social period where all concerned have an opportunity to renew old acquaintances and meet new friends. We hope to have more meetings of this type before the season is over.

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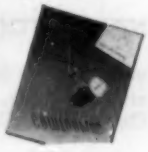

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MICHIGAN Quality control training is really growing into a major component of the section's activities. On Oct. 8 an eight week presentation (Training Course II) was begun with such notables as Raymond L. Clark and William Courtright of Argus Cameras, Inc., Stephen J. Adams of Wolverine Tube Div., Calumet & Hecla, Inc., Harmon S. Bayer, quality control consultant, and Nelson G. Meagley of Lincoln Div., Ford Motor Co. The classes were held on Monday night at the Veteran's Memorial Building in Detroit. Plans for the spring of 1957 include a repeat of Course I and the introduction of Course III. These courses are the results of the requests of Michigan's industry.

The Wolverine subsection held its panel discussion Oct. 5 at Western Michigan College in Kalamazoo. "Trends in quality control" was the format of the evening's activity. The panel members (Richard Trelfa of Watervleit Paper Co., Dr. O. S. Carpenter of Upjohn Co., William A. Schilder of Valve Div., Eaton Mfg. Co., Harley F. Lepper, Post Cereals Div. Gen. Foods Corp.) did an excellent job in answering the questions of the evening. Dr. Fred Beeler of Western Michigan College acted as moderator.

The Michigan section opened its season with a vibrant double-header. The American Society for the Advancement of Management co-sponsored an informative talk by August B. Mundel of Sonotone Corp. Mr. Mundel spoke on the "Management of quality control and inspection."

Earlier that same evening, Thomas P. Brewster of the Ford Motor Co. delivered the first advanced education lecture of the season. "Linear correlation" was Mr. Brewster's subject.

MID-HUDSON W. Babalke of the section has arranged and is conducting an adult education course at Arlington High School at Poughkeepsie. Bill, who is conducting this course for the 7th consecutive year, has over 400 graduates from area industries who are spreading the gospel of SQC.

Harold Freeman, GE quality engineer, was principal speaker at the October meeting. Harold discussed "What management expects of the quality engineer" outlining a few basic approaches to a quality problem and several criteria employed by management in evaluating the contribution of a quality program.

MILWAUKEE Art Benscoter of the A. O. Smith Co., Kankakee, Ill., gave an excellent talk on Oct. 22 entitled "QC applications in the appliance industry." He elaborated on the consumer quality index used in the final inspection.

Irv Schoeninger's special education lecture on the t-test brought out one of the largest crowds in years. It brought out a larger group than our free beer hour has and in Milwaukee that's something!

MUNCIE Our second meeting of the season, held on Oct. 18, was a pleasant success. We were pleased to be able to present an address by Thomas E. Turner of the Diamond Chain Co. of Indianapolis. His remarks, entitled "Administering a quality control plan," had the rather rare quality of appealing to our "in-the-know" members as well as to our "new-to-quality-control" guests.

NEW HAVEN The section was well represented at the 10th New England QC Conference held in Springfield. Local members who were instrumental in making the conference a success were George Georgis and David Albert.

On Oct. 16 section members were conducted on a plant tour through the Arms and Ammunition Div. of Olin Mathieson Chemical Corp. George Frost, quality control manager, was host.

The executive committee met at the home of Welton D. Parker on Oct. 9. Plans for the 1956-57 educational program were finalized. The two courses to be offered are "Basic quality control" and "Statistics for engineers."

ROCHESTER The section had as its speaker on Oct. 16 Edward Oakley, supervisor, quality control, Delco-Remy Div., GMC. His approach to "Introduction to statistical quality control" is novel and spectacular. He uses a device, illuminated by black light, which demonstrates random distributions and the ways in which such distributions are, or may be, affected by human errors. It was a worthwhile session.

ST. LOUIS The October meeting was a most enjoyable one with an excellent talk on "Legal uses and implications of statistical data" by Professor F. R. Kennedy which was of great interest to all.

The section also had the pleasure of presenting the St. Louis University Library with beautifully bound copies of four years of *Industrial Quality Control*. The presentation was made by John Randall in behalf of the section to Father Bloom. Dr. W. Veazeau, Dr. Regan, and Mr. V. Jones, all of the St. Louis University Staff, were also present to receive the presentation which was given in appreciation for using the University facilities for a number of years.

SALT LAKE CITY The section experimented with Saturday afternoon meetings on Oct. 6 and Nov. 3 presenting programs consisting of basic and advanced educational sessions running concurrently, followed by a short business meeting and news from around the country. After an intermission, the featured speaker is introduced.

The Oct. 6 meeting consisted of a lecture on correlation by Professor Ernest Randa of the University of Utah, a report on the West Coast Quality Control Conference by Julius Billeter of Hill Air Force Base, and "Use of statistical techniques in the chemical industries" by Dr. Carl A. Bennett of the Hanford Atomic Products operation.

SAN DIEGO A panel meeting was held Oct. 8 at the North Park Club. The panel consisted of local authorities on processing. D. K. Krosch of Solar presented "Process and quality control of aluminizing procedures; R. J. Taylor of Rohr, the "Relationship of destructive to non-destructive testing as a means of quality control in process inspection; A. L. Smith of Ryan, "Process control of heat treatment"; B. R. Swartz of Convair, "Magnetic inspection process capabilities; Earl Smith of Solar acted as moderator.

SCRANTON -WILKES-BARRE The regular meeting consisted of a very educational plant tour of the Consolidated Moulded Products Co. in Scranton at 4 pm on Oct. 22. A dinner meeting followed by a question and answer period relative to the plant tour, was held at 6 pm. Harold Dumoff, chief inspector of consolidated, answered several questions relative to his quality control program and at 8 pm the J. C. Penny Co. sound film "QC in modern merchandising" was shown.

SEATTLE H. S. Rice, plant division manager, Frozen Food Div. of Stokely-Van Camp discussed the effect of quality control on production operations aside from direct product quality considera-

tions at the October meeting. The meeting was held in the quality control laboratory of the production department of Stokely-Van Camp in Mount Vernon, Wash. Approximately 50 members, their wives, and guests attended the meeting and toured the plant.

SOUTH BEND -MISHAWAKA The section members were guests of Miles Laboratories in Elkhart. Miles, makers of Alka-Seltzer, Bactine and other well known pharmaceutical items, provided three speakers. Lloyd T. Johnson spoke on "The control laboratory;" Emmet W. Manley discussed "Identity control department;" and Robert Hafer detailed "Control limits applied to production forecasting."

The basic course in statistical quality control offered by the section to local industry has a maximum enrollment. The 13 week course will be followed by an advanced quality control school.

SOUTH TEXAS An inspection trip through Cameron Iron Works, Inc. at Houston, Texas was enjoyed by members and guests of the section on Oct. 10. After the inspection trip and dinner, G. Erwin Nevil, who is the manager of quality control for Cameron Iron Works in Houston, gave a report on the progress of quality control in their plant.

TOLEDO On Oct. 4 the section members were guests of the Pure Oil Co. Refineries in East Toledo. The plant tour was well conducted by their supervisory staff and included a trip through the cracking and refining operation as well as a complete explanation of their control methods on quality and purity. Dinner was followed by a lively discussion on the many areas of oil and gasoline production.

TORONTO On Oct. 10 the section enjoyed an explanation of the Span Plan method of process capability analysis given by Leonard A. Seder of Malden, Mass. This was followed by a visit to the packaging test laboratory of the Hinde & Dauche Paper Co. in Toronto on Oct. 24 under the guidance of W. Ostrowsky where members had an opportunity to observe testing methods used in the paper industry.

UNIVERSITY OF WESTERN ONTARIO A plant tour of Standard Tube & T. I. in Woodstock was enjoyed by a group of 83 local members. A talk on company background and a discussion on quality problems along with light refreshments completed the evening.

WACO On Oct. 22 R. L. Storer, assistant manager of the quality control branch, Rocket Fuels Div., Phillips Petroleum Co., presented "Quality control and the law of contracts." Mr. Storer recently joined the quality control staff of Phillips after about 10 years of quality control work with Army Ordnance. During the last two years of his ordnance experience, his area of responsibility included the preparation of Army ammunition specifications. He has discovered some intriguing problems relating to industrial purchases and government contracts. The meeting was held in Room 6, Morrison Constitution Hall, Baylor University.

WESTERN MASSACHUSETTS The 10th New England Conference from the point of view of attendance and financial return to the New England sections has been the most successful ever held. There were 521 people who registered and attended the sessions. Chairman William Carter and all his aides deserve well earned credit and recognition for producing an outstanding conference.

WINDSOR On Oct. 10 the Ford Motor Co. of Canada, Ltd., was host to the section. Members and guests were conducted through the engine plant by the plant manager, W. F. Tyson, and members of his staff. Following the tour, everyone assembled in the plant lunch room where many of the interesting items encountered were discussed over coffee and donuts.

WORCESTER On Oct. 18 a panel program was held at Worcester Polytechnical Institute. Men from local industry sat as members of the panel and answered questions on every phase of quality control for almost two hours. This was a most interesting evening and more are planned for the future.

Warren Arnold acted as chairman with James Gilman, Charles Reed, Kenneth Smith, and Charles Hudson as panel members.

"... CAST THEIR SHADOWS BEFORE"

ALBUQUERQUE Hugh P. Campbell, quality manager, Glen L. Martin Co., Denver, Colo., will speak Jan. 14 at the regular section meeting. His subject will be "Inspection during development and experimental programs."

The educational session will be led by G. J. Lombardi who will start a review of a paper by C. R. Hicks, entitled "Fundamentals of analysis of variance, Parts I,

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II, III" which appeared in the August, September, and October 1956 issues of *Industrial Quality Control.*

ALLENTOWN -BETHLEHEM The January meeting, scheduled for the ninth at Walp's Restaurant, will feature participation by section members. The purpose of the program will be to illustrate the results of the establishment of industrial quality control programs, and to discuss experiences in introducing these programs.

BINGHAMTON The January meeting of the section will be held at the General Electric Co., Johnson City, N. Y. Mr. Leon Bass of the General Electric Co., Evendale, will speak on "Make it right the first time." A plant tour of the GE plant will precede the dinner and meeting.

BOSTON A change in speaker for the regular meeting scheduled for Jan. 16 is announced. Mark Princi, manager of engineering, General Electric Co., West Lynn, will talk about the engineer's view of quality control.

BUZZARDS BAY Fred J. Berkenkamp of the General Electric Co. in Schenectady, N. Y. will be main speaker at the Jan. 8 meeting to be held at the Continental Screw Co. His topic will be "Quality costs—a powerful measurement and programming tool."

CHICAGO On Jan. 8 the section's first meeting of the new year will be sponsored by the basic education committee. It will be held in Room 785 of Roosevelt University. Speakers will be announced well in advance of the session.

CINCINNATI On Jan. 16 "Validity of measurements" will be the topic of the speech delivered by Dr. Louis Fowler, assistant chief chemist of the Monsanto Chemical Co., St. Louis.

The Hamilton subsection on Jan. 9 will have Leo J. Nartke, Delco Products Div., GMC, Dayton, Ohio, who will speak on "Frequency distributions."

CLEVELAND C. Austin Barker, of the Cleveland Illuminating Co., will be the speaker of the Jan. 4 meeting. The subject of his talk will be "The uses of statistics in financial investments."

COLUMBUS Our January meeting will be held Jan. 16 at 8 pm at the Columbus plant of Westinghouse. Frank Caplan, Jr., manager of quality control of the Westinghouse Atomic Fuel Department will talk on "Vendor rating and certification." Mr. Caplan is a mechanical engineer, graduate of Cornell, and a senior member of the Society. Many of his papers have been published in IQC.

CORNING -ELMIRA The first meeting of the new year will be held on Jan. 8 at the Baron Steuben Hotel, Corning. The speaker for this dinner meeting will be J. Manuele, director, headquarters quality control, Westinghouse Electric Corp., Pittsburgh, Pa., who will discuss "Management accepts quality control."

DALLAS -FORT WORTH Dorian Shainin, past vice president of the Society and consultant employed by Rath and Strong, Boston, will address the section on "Breaking through industrial problems barriers." As the author of many

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provocative articles and techniques on quality control especially those dealing with Lot Plot techniques, short-run techniques, and other statistical tools to evaluate quality characteristics as well as maintain and control process quality, it is believed that Mr. Shainin will provide those in attendance with helpful information regarding the attack on the "tougher" industrial problems. The meeting place will be the Arlington State College; the time—8 pm on Jan. 10.

DAYTON The regular meeting for the month of January will be held on the tenth at the Branch House in the form of a dinner meeting. The speaker will be J. A. Daview of the General Electric Co. who will talk on variables sampling without calculation.

DELAWARE The January meeting of the section will be held at the De La Warr Hotel in Wilmington on Jan. 10. Although the program is not yet firm (we had a disappointment in our original plans) we expect to have an interesting talk on work sampling. Definite details for this meeting will be announced later.

ERIE Jan. 16 will find us meeting jointly with the American Institute of Industrial Engineers. They will act as host and are providing the speakers. James Lincoln of Lincoln Electric will speak on "Incentive management." Our joint meetings with AIIE are on a home-and-home basis. That is to say we provide the speaker one year—AIIE the next.

GREATER MUSKEGON The December meeting of the section will be held at Bill Stern's Steak House. John E. Rutledge, chief inspector of the McDonnel Aircraft Corp., St. Louis, will speak. Mr. Rutledge's topic will be "Quality control without statistics."

HARRISBURG The next meeting will be held on Jan. 7. This is a change from our usual first Wednesday, but it was thought necessary because of New Year's day falling on the preceding Tuesday.

As usual, our January meeting will be held at Hostetters' in Mount Joy so that everyone will have about equal driving distance in case of bad weather.

Our speaker that evening will be Paul Clifford of Montclair State Teachers College who will give us a discussion of "The fundamentals of quality control." It will benefit us all, I'm sure, to review these basic ideas with one of the best known men in the QC field.

KANSAS CITY The guest speaker for the section's January meeting will be John W. W. Sullivan of the American Iron and Steel Institute. His subject will be "Statistical methods in steel technology." The monthly pre-dinner clinic will start at 6 pm on Jan. 9 at the Blue Hills Restaurant.

MICHIGAN The social event of the section will take place Jan. 19 at the Park Shelton Hotel in Detroit. Harmon S. Bayer, Detroit quality control consultant, will be our dinner speaker. Mr. Bayer's topic will be "Ladies—can you use quality control?" Dinner will be followed by dancing.

MID-HUDSON Dr. A. S. Schultz of the Sibley School of Engineering at Cornell University, will discuss "Operation research" at the January meeting. The meeting will be held on the second at Nick Beni's Anchor Inn in Poughkeepsie.

MUNCIE Our section is planning to launch the new year on a successful journey by presenting on Thursday evening, Jan. 17, an address on capability studies by Edward Oakley, supervisor of statistics, Delco-Remy Div., GMC. A discussion of capability studies usually draws a crowd in our section and we hear Mr. Oakley's address on the subject is one of the best. That's the way we like to start a new year!

RACINE John Harrington of the DoALL Co. will be the kickoff speaker of 1957 for the section on Jan. 14 at the Eagles Club. Mr. Harrington will speak on "Principles and techniques of precision measurement" and with many inspection personnel in the attendance this meeting shoull be filled with inquisitive questions by the membership at the close of the address. "We look forward to your visit, Mr. Harrington."

ROCHESTER On Jan. 15 the section will present as the speaker C. G. Rittenhouse, ass't. sup't., cine & sheet film div., Eastman Kodak Co. Mr. Rittenhouse will discuss "Management reaction to statistical quality control in production."

On Jan. 8 the gaging and measurement sub-group of the section will meet with Frank W. Kabat, sales manager, Micrometrical Mfg. Co. Mr. Kabat will present a "History of surface roughness."

SAN DIEGO The topic for presentation at the Jan. 14 meeting is "probability of electronic components" and will be discussed by O. S. Olds, chief electronic engineer of Ryan Aeronautical. This is to be a dinner meeting at the North Park Club. The social hour starts at 6 pm with dinner at 6:30 pm followed by the meeting at 7:30 pm.

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SOUTH BEND -MISHAWAKA Management night will be held on Jan. 17. The speaker will be A. C. Omberg, asst. general manager of Bendix Products Div., Missiles. His subject will concern "Modern methods of making decisions—using mathematics." This is "bring the boss night" and a large crowd is expected for the dinner meeting.

SOUTH TEXAS In January, Dorian Shainin of Rath & Strong, Boston, will talk to a joint meeting of the section and AIEE on "Breaking through the industrial problems barriers."

Six committees made up of 28 members of the section are working full blast to prepare an excellent all-day conference on QC. The program so far looks well-rounded; it should satisfy the manager and the technician.

TORONTO The first meeting of 1957 will be held at the Botany Building, University of Toronto, on Jan. 9 when J. N. Watson, British American Oil Co. will speak on "The application of control charts to operating expense."

UNIVERSITY OF WESTERN ONTARIO A joint meeting of the Hamilton and the University of Western Ontario sections of the American Society for Quality Control will be held at the Brant Hotel. The meeting is scheduled for Jan. 16. The meeting is to be in the form of a manager's panel. This will be one of the highlights of the season as managers give their respective views on the subject of quality control. The panel chairman will be J. W. Jolly, general manager of Standard Tube & T. I., Ltd.

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WESTERN MASSACHUSETTS On Jan. 8, J. S. Wiberley, assistant supervisor, inspection section, Socony Mobile Oil Co., will lecture to the section as to "Micro-chemistry in the solution of some technical service problems in the petroleum industry." The meeting will be held at the Sheraton-Kimball Hotel, Springfield, Mass. Dinner is at 6:30 pm with the lecture following at 8 pm.

WINDSOR A technical meeting is scheduled for Jan. 16. Members will be notified by mail of the meeting place and the speaker's name.

"AS YE SOW . . ."

ALLENTOWN -BETHLEHEM The first class of Course Two, basic statistical quality control, will be held under the sponsorship of the section on Jan. 7. Weekly evening classes will be held at Muhlenberg College through February.

CORNING -ELMIRA The section will sponsor a one day seminar to be held at the Corning Glass Center on Jan. 12. The theme of the conference will be "Quality control at work in the Corning-Elmira area." The material presented will vary from the description of quality control systems and case histories to experimental design. Speakers for the day include Dr. A. Schultz, Dr. R. Bechofer, and J. Kao of Cornell University; A. Stone and S. Frankel of Corning Glass Works; J. Evon and L. Garlick of the Westinghouse Electric Corp.; and R. Wurzell of the National Cash Register Corp.

DALLAS -FORT WORTH On Tuesday, Jan. 15, a nine session course entitled "Basic course in statistical quality control" will be offered to members of the Dallas-Fort Worth section as well as those who have an interest in quality control or those who wish to take a refresher in the particular proven statistical techniques. Qualified instructors from the membership will conduct the classes utilizing demonstrations and visual techniques to illustrate the practical applications of these tools in maintaining control of quality. The series will be held on the campus of Arlington State College. Dr. John L. Wortham of Texas Christian University is the director of the educational committee of the section which is responsible for the presentation of the course.

DAYTON The basic course in quality control techniques will be offered sometime during January. A definite starting date has not been set as yet. This course will be given for 12 weeks and the instructor will be Dr. Max Astrachan of the USAF Institute.

GRAND RAPIDS Jack Rutherford of Lear, Inc. and K. C. Brown of American Seating Co. have developed a course of educational sessions to be held in addition to our monthly meetings. The course is to begin the second week of January and is titled "Development of quality control." This will be composed of 12 sessions.

MILWAUKEE Everett Hokanson of the Blatz Brewing Co. is the general chairman of the annual clinic to be held about Mar. 18. A new section in administrative applications is being planned.

ROCHESTER The 13th annual quality control clinic to be co-sponsored by the Rochester section and the Rochester chapter of the American Statistical Association will be held in the War Memorial Auditorium on Feb. 19, 1957. Thomas Soebbing is clinic general chairman.

The clinic is an all-day affair which will include the presentation of approximately 20 technical papers on all phases of quality control and industrial statistics. In addition, there will be 20 exhibits of the latest in mechanical and electronic gaging and measuring equipment, as well as data processing equipment.

SEATTLE The section will conduct an all-day QC workshop in January at which the participants are invited to submit questions and problems to a panel for discussion and possible solution. The meeting will be held at the University of Washington, Student Union Building. Date and meeting room will be announced later.

WESTERN MASSACHUSETTS Jan. 16 seems to be the starting date for the "operation and research" series of lectures to be co-sponsored by the section and the Massachusetts University Extension.

NATIONAL SYMPOSIUM RELIABILITY AND QC IN ELECTRONICS The third national symposium on reliability and quality control in electronics will be held on Jan. 14-16, 1957, at the Hotel Statler in Washington.

The above picture shows a segment of the group of people who will be responsible for the tremendous success predicted of this symposium. They are: (seated, left to right) M. E. King, August B. Mundel, Max M. Tall, and Dr. Victor Wouk; (standing, left to right) Richard M. Jacobs, Robert G. Murrell, James E. Culbertson, J. Walter Greer, and Irvin W. Schoeninger.

AMERICAN ASSOCIATION ADVANCEMENT OF SCIENCE, DECEMBER 26-27 Section M, Engineering, of the American Association for the Advancement of Science is holding a two-day session in the Grand Ballroom, Statler Hotel, New York, Dec. 26-27. The general theme of the session is "Aids for environmental control."

The program is subdivided into three sections. Section I, to be presented Wednesday morning, is entitled "Overcoming normal and abnormal physical limitations" and is under the chairmanship of Eugene F. Murphy, Ph. D., Veterans Administration. Section II, "Extending mental and rational powers," will be presented that afternoon. Dr. Irving P. Orens, Newark College of Engineering, will be chairman. Thursday morning's session will be under the chairmanship of Dr. John Lotz, Columbia University. Each session will include presentations by notables in their respective fields.

INDIANAPOLIS Continuing interest in the basic SQC and control chart course has enabled the section to present two separate schedules. The first schedule is being given to a one-semester group which receives an accelerated course reminiscent of the ES-MTW courses given in colleges throughout the country during World War II. The two-semester schedule includes an introduction to the law of large numbers and process capability, then a flash-back review of basic math before going into the second semester for practice with control chart techniques. An acceptance sampling course is also given each semester.

Classes in tests of significance and administration of the quality control program will begin on Tuesday and Thursday evenings, respectively, the week following the one-day technical sessions at Butler University, Jan. 25, 1957.

"FOR MANY ARE CALLED, BUT FEW ARE . . ."

DAYTON Due to the resignation and transfer of our former vice chairman Fred Reinhold, J. C. Sollenberger, our former treasurer, has been appointed vice chairman, and C. E. Baker, our former Saddoris Award committee chairman, has been appointed treasurer.

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MID-HUDSON Officers for the 1956-57 year are P. F. Heitz, chairman, IBM, Military Produets Div.; J. Losee, vice chairman, DeLaval Separator Co.; D. Gale, secretary, Bobrick Products Corp.; W. Cranston, treasurer, Western Printing & Lithographing Co.

SAN DIEGO Nancy Brombacher, vice chairman, returned to Maryland leaving a vacancy which was filled by Gene Fleming of Rohr Aircraft Corp., Chula Vista, Calif.

DIVISIONS

Chemical Division

The fall meeting of the Chemical Division Council was held in Ann Arbor, Mich. in September. All the officers and 50 percent of the councilors were in attendance. During the meeting, which extended over two days, much worthwhile action was taken which should contribute to the value of membership in the division.

A second session of the division's course on the Box Method of experimentation was held at the University of Michigan in October with Dr. J. S. Hunter of American Cyanamid again instructing. A third session will be held in Houston, Texas, in February.

MEMBERSHIP CORNER

The Youngstown section's experience has been like many other sections in that its original establishment and first years were characterized by concern of its members that it might not hold up. At this point it is apparent that these worries are no longer valid since Youngstown is now a healthy, active, and growing section. Perhaps other struggling sections will take heart by their experience and follow their pattern to solid footing. The following letter was received from them and we are happy to include it in the Membership Corner.

Mr. Harmon S. Bayer
1154 Book Building
Detroit 26, Michigan

Dear Mr. Bayer:

Chester Smith, the Chairman of the Youngstown Section has asked me to drop you a line explaining some of the methods used to increase our membership last year. Perhaps the most effective of these was our educational program conducted by Mr. Smith, which offered an excellent course in Statistical Quality Control at a very reasonable cost to members of ASQC. This, of course, prompted quite a few to become members of ASQC in

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Is Your Section "High" or "Low" Man on the Totem Pole?

1. Albany
2. Albuquerque
3. Baton Rouge-New Orleans
4. Birmingham
5. Boston
6. Burlington
7. Chicago
8. Cincinnati
9. Cleveland
10. Columbus
11. Corning-Elmira
12. Cumberland
13. Dallas-Fort Worth
14. Danville-Sunbury
15. Dayton
16. Erie
17. Greater Muskegon
18. Hamilton
19. Harrisburg
20. Huntsville
21. Indianapolis
22. Iowa
23. Japan
24. Kansas City
25. Lincoln
26. Metropolitan
27. Mexico City
28. Milwaukee
29. Minnesota
30. Montreal
31. Parkersburg
32. Philadelphia
33. Pittsburgh
34. Rhode Island
35. Richmond, Va.
36. St. Catharines
37. San Antonio
38. San Bernardino
39. San Diego
40. San Francisco
41. Scranton-Wilkes Barre
42. Southern Connecticut
43. Syracuse
44. Tennessee
45. Tucson
46. Utica
47. Western Massachusetts
48. Western Ontario
49. Wichita
50. Windsor

At the left are listed in alphabetical order all of the sections whose membership performance is significantly better or worse than the average. Using each section's membership as reported to the Milwaukee office by Oct. 31, 1956, performance was calculated as a percentage of last year's membership at June 30.

The sections listed at the left are those that fall above or below the 95 percent confidence band. Kudos to those on the high side. To those that lowered the average, our sympathy. Is there anything we can do to help you pick up the ball, or have you just been coasting on your laurels?

See if you can tell which of the sections are good and which not so. The two groups, identified by their numbers, are printed upside down below.

Performance significantly better than average:
2, 5, 8, 10, 11, 12, 15,
16, 17, 19, 20, 23, 24, 25,
26, 27, 28, 29, 30, 32, 33,
35, 39, 40, 44, 47, 48.

Performance significantly poorer than average:
1, 3, 4, 6, 7, 9, 13, 14,
18, 21, 22, 31, 34, 36,
37, 38, 41, 42, 43, 45,
46, 49, 50.

order to participate in the course. It then became a matter of maintaining their interests in the society.

We have also encouraged our active members to contact personally other individuals within their own plant and in plants in their immediate neighborhood. This is particularly effective in industrial areas made up of a number of small or medium sized plants. A third method that was tried last year consisted of approaching the Secretary of the County Manufacturing Association (a member of N.M.A.). He supplied us with the names and addresses of the heads of each manufacturing organization in the county. A letter was addressed to each of these outlining our program and urging them to encourage their personnel to participate. All of these methods were used in addition to the usual direct contact of leads afforded by members and guests.

I hope that this will be of some value to you in your discussions with other sections.

Very truly yours,
J. R. Nielson

We are sure that Youngstown members and officers can take pride in a job well done.

SIGNIFICANT DIFFERENCES

J. Frederick Verigan, Baltimore section, has been named division manager of quality control for the Crown Cork and Seal Co., Inc., Crown and Closure Div., Baltimore. Mr. Verigan is a national director and a Fellow of the Society.

Oliver Beckwith, Boston section, formerly with Fabric Research Laboratories, has recently joined the staff of the William Carter Co. in Needham Heights.

Herbert Sears of Biddeford, Maine, has transferred from the Boston section to the San Francisco Bay Area section.

Walter F. Kubisty, Jr., publicity chairman of the Buffalo section and formerly an analytical statistician in the engineering division at the office of Assistant Inspector of Naval Material, Cheektowaga, N. Y., has been transferred to the office of Inspector of Naval Material, Buffalo, N. Y. as a procedures division supervisor in the quality control department.

Welcome back to the Burlington section to Charles F. Pearson of National Carbon Co., St. Albans, Vermont. Charlie, who was formerly head of the Works Lab at Cleveland has returned to St. Albans as head of industrial relations. Many Burlington section members will remember him as our first vice chairman.

Chicago section member Henry Jacobson was appointed a member of the Radio-Electronics-Television Manufacturers' Association (RETMA) sub-group on quality acceptance.

C. T. Shewell, senior member of the South Texas section, has been promoted to senior research specialist in the research and development division of Humble Oil and Refining Co.

William Soudriette returned to the Chicago area from the Cities Service Oil Company's home office in Bartlesville, Okla. to be plant manager of the company's East Chicago, Ind. facility.

David O. Berke, Corning-Elmira section, was recently appointed manager of quality control, technical products division, Corning Glass Works, succeeding Martin E. Dykeman, who was appointed sales engineer, western region, for Railroad and Industrial Appliance and Optical Sales. Mr. Dykeman, a charter member of the Corning-Elmira section, will reside in Los Angeles, Calif.

Charter member of the Louisville section Marion A. Cline has been elected chairman of the Louisville Engineering and Scientific Societies' Council. This council is composed of representatives from 24 technical societies having a combined membership in excess of 2500.

A. E. Guldenschuh, past chairman of the Mid-Hudson section, has been transferred by IBM from its Kingston Military Products Division to California. Art is quality control project manager at the San Jose plant and has become affiliated with the San Francisco Bay Area section.

Two recent changes in the structure of the U. S. Hoffman Machinery Corp. have affected the Scranton-Wilkes-Barre membership. Member Clyde L. David accepted a position as supervisor of quality control at Kanori Aviation Corp., Kingston, Pa. Member Francis Shiner has been appointed to fill Mr. David's vacancy at Hoffman.

E. F. Dertinger and Richard Chamness, of the South Bend-Mishawaka section, have joined Arma Bosch in Garden City, Long Island. Mr. Dertinger will head the reliability and weight and balance department.

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The Calumet subsection of the Chicago section reports that Edward Gustely, formerly of Standard Oil Co. in Whiting, Ind., is now head of quality engineering for Aerojet Division of General Tire and Rubber Co. in the Los Angeles area.

William Carter, past chairman of the Western Massachusetts section and this year's New England Conference chairman, is now lecturing in applied statistics at a graduate engineering course sponsored by Rensselaer College in the Hartford, Conn. area.

Bibliography

JOSEPH MOVSHIN, *Editor*

Assisted by the Editorial Committee, St. Louis Section, ASQC

9220 Old Bonhomme Road, St. Louis 24, Mo.

APPLICATION—MISCELLANEOUS

QUALITY CONTROL CHARTS PLATING SAVINGS, by Guy J. Campbell, (Ternstedt Division, General Motors Corp., Detroit)
(Steel, The Metalworking Weekly, v. 139, n. 4, July 23, 1956, p. 90-92)

The use of control charts for control of plating is recommended. Defects are found and identified immediately after parts pass through the plating process. Corrective measures are initiated as soon as the defects can be identified. Considerable savings in the use of plating chemicals are reported in addition to better control of quality.

MORE CONTROL WITH LESS PAPERWORK, by James H. Flaker, (Administrative Coordinator) and David Albert, (Group Leader, Statistical Quality Control)—(Lycoming Division of Avco Manufacturing Corp., Stratford, Conn.)
(Factory Management and Maintenance, v. 114, n. 9, Sept. 1956, p. 150-151)

It is possible to simplify the paperwork necessary for inspection and still develop the essential information needed for the control of quality. An illustration of a simplified inspection check chart and data sheet is given indicating space for the check of many items over a long period of time and for the development of summary material. Advantages indicated are: reduced cost for paper, the need for less file space, saving in paper-handling time and better quality control through easier use of the data.

ENGINEERING AND EXPERIMENTS

FINISH MEASURING TECHNIQUES, by E. W. Bolles (Micrometrical Manufacturing Co., Ann-Arbor, Michigan)
(Grinding and Finishing, v. 2, n. 4, Aug. 1956, p. 30-37)

The ASA (American Standards Association) surface finish standards are described. A table of definitions and symbols is given. Other tables show the various processing techniques together with finishes obtained, typical applications, and tolerances associated with the finish. Another unusual table shows a comparison of many surface finish measuring techniques, their areas of application, accuracy and effects in terms of various considerations.

MANAGEMENT & PERSONNEL, GENERAL

WAGE INCENTIVES FOR INSPECTION, by Fred H. Lambrou, (Chief Industrial Engineer, Gruen Precision Products)
(The Journal of Industrial Engineering, v. VII, n. 5, Sept.-Oct. 1956, p. 236-237)

The author describes a wage incentive program for inspection in some detail. Necessary steps in the development of a program to measure inspection work are outlined. These are discussed in limited detail. They are: 1) Classify work into two categories: a) Directly measured work, b) Indirectly measured work; 2) Set up inspection standards and define them; 3) Make preliminary studies and set methods; 4) Train the inspectors in the new methods; 5) Time the work and establish time standards; 6) Establish and apply the quality incentive.

Selected references in the Bibliography of *Industrial Quality Control* are obtained from the following sources:

The International Statistical Institute, *International Journal of Abstracts on Statistical Methods in Industry.*

HOW TO GET MORE FOR YOUR INSPECTION DOLLAR
(The Iron Age, v. 178, n. 13, Sept. 27, 1956, p. 209-224)

A somewhat complete discussion of Inspection and Quality Control problems, from both the standpoint of physical inspection and organizational relationships is presented. Some of the headings of the various sections indicate the nature of the material discussed. Section 1—Objectives: Inspection vs. Quality Control, Objectives, Receiving Inspection, Standards, In-process Inspection, Rework and Salvage; Section 2—Organization: Master Plan, Functions, Personnel, Job Description, Job Evaluation, Equipment. The importance of organization and manufacturing attitudes as well as of the physical method of inspection are stressed.

PRODUCTION QUALITY CONTROL CHARTS, by Sterling F. Winchell, (Chief Quality Control Engineer, Warner & Swasey Corporation)
(Machine & Tool Blue Book, v. 51, n. 10, Oct. 1956, p. 152-154)

This article describes the problem of selecting the best operator and machine to produce a given part. Very briefly, this article suggests the use of a control chart to observe the function of the operator and machine for a given part.

INDUSTRIAL MANAGEMENT

WORK SAMPLING APPLIED TO LONG CYCLE OPERATIONS PERFORMED BY A VARIABLE LABOR FORCE, by Joseph J. Moder, Jr., and William J. Halladay, Jr., (School of Industrial Engineering, Georgia Institute of Technology)
(The Journal of Industrial Engineering, v. VII, n. 4, July-Aug. 1956, p. 164-167)

Binomial distribution is applied to the analysis of work sampling

under certain conditions described in this article. The number of observations, method of sampling, and analysis of results are given. The accuracy of work sampling estimates for this type of study is indicated. The problem of applying work sampling to long cycle variable labor operations has not always been simple but can be successfully done with the techniques described. Some of the limitations and problems of this method are also indicated.

STATISTICAL PROCEDURES IN STOP WATCH WORK MEASUREMENT, by John M. Allderige, (Technical Advisor, Industrial Engineering Division, Kodak Part Works, Eastman Kodak Co.)
(The Journal of Industrial Engineering, v. VII, n. 4, July-Aug. 1956, p. 154-163)

Several basic questions to time study are studied from a statistical viewpoint. These are: 1) How many readings are required? 2) Are the data consistent? 3) What is the reliability of the final answer? Some of the problems relating to time measurement are presented. A simple example is used to show the usual statistical approaches to these problems. These include the $\overline{X}$ and R chart, determination of the number of measurements needed from the standpoint of a certain probability associated with the observed answer. An example and full step-by-step details of the procedure are outlined. The approach without the use of a range chart is also indicated and the development of a nomograph for sampling size and precision determination is presented.

MISCELLANEOUS

BUILT-IN GAGES . . . STOP FURTHER WASTE, by Clifford T. Bower, (London, England)
(The Journal of Industrial Engineering, v. VII, n. 5, Sept.-Oct. 1956, p. 69-71)

This article describes some assemblies whereby the design of a jig or fixture can have incorporated in it, attribute limit gages which will reject pieces before the next operation.

KEEP TRACK OF YOUR GAGES (AND YOUR CUSTOMERS'), by Albert L. Levitt (Bronx, New York)
(Tooling and Production, v. XXII, n. 7, Oct. 1956, p. 202-205)

The problems of gage control in a small shop, particularly if some of these gages belong to customers,

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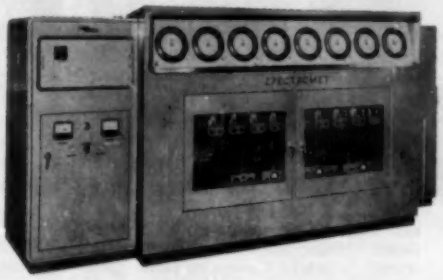

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are difficult ones. The use of a card index set-up when the gage is received is suggested. Gage control charts to supervise gage inspection and maintain the history of the gage is employed.

OPERATIONS RESEARCH

OPERATIONS RESEARCH—THE SCIENTISTS' INVASION OF THE BUSINESS WORLD, by Dr. Dean E. Wooldridge, (President, the Ramo-Wooldridge Corporation)

(The Journal of Industrial Engineering, v. VII, n. 5, Sept.-Oct. 1956, p. 230-235)

The author describes operations research in terms of its broad concept and what it's trying to do for its customer. Basically, operations research says to management, 'Anything you can do, I can do better'. Operations research is presented as a tool whereby management can approach the complex problems involving all aspects of organization, men, and equipment. The place of the scientists in developing this concept is discussed. The development of this technique through World War II and the period following the war is indicated. The need for objective quantitativeness and capacity to invade new fields is necessary for the scientists in operations research.

THE ROLE OF MATHEMATICS IN OPERATIONS RESEARCH, by Dr. Andrew Vazsonyi, (Head, Management Sciences Research, The Ramo-Wooldridge Corporation)

(The Journal of Industrial Engineering, v. VII, n. 5, Sept.-Oct. 1956, p. 201-209)

Operations research is discussed with primary emphasis on the use of mathematical tools and models in the solution of problems. Basically, mathematics makes it possible to describe and understand a business situation better than any verbal description can. In specific cases, mathematics may be the only way of describing it. The ability of mathematics to express complicated industrial situations is illustrated in several specific cases. These include: A pictorial representation for parts listings and requirements where there may be thousands of parts sheets for relatively the same assembly. The quantities of each required can be set up and the mathematical formula is indicated. The next problem involves scheduling of such a complicated situation. Again, mathematics are developed to provide a formula for scheduling and also for machine loading. Eight advantages are presented for the use of mathematical models. These are: 1) A mathematical model indicates what data should be collected to deal with the problem quantitatively. 2) A mathematical model establishes indices of effectiveness and control. 3) The mathematical model makes it possible to use mathematical techniques that otherwise appear to have no applicability to the problem. 4) The mathematical model makes it possible to deal with the problem in its entirety and allows a consideration of all the variables of the problem simultaneously. 5) The mathematical model is capable of being enlarged step by step to a more comprehensive model, to include factors that are neglected in verbal description. 6) The mathematical model uncovers relations between the various aspects of the problem which are not apparent in the verbal description. 7) The mathematical model prepares the ground-work for the introduction of large-scale

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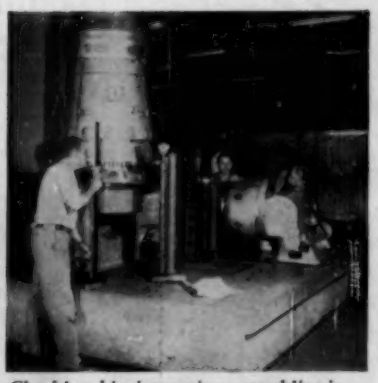

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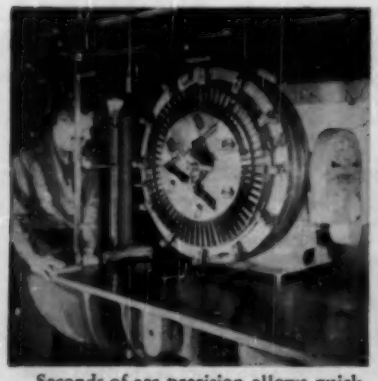

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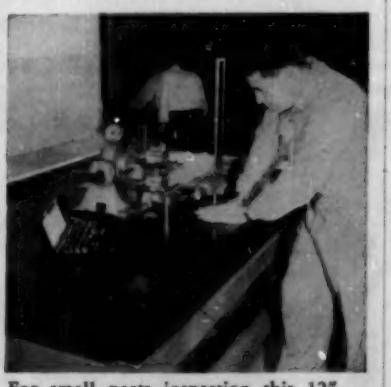

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electronic data processors. 8) The mathematical model frequently leads to a solution that can be adequately described and justified on the basis of a verbal description.

OPERATIONS RESEARCH . . . AS IT IS APPLIED TO PRODUCTION PROBLEMS, by Alan H. Gepfert and Charles H. Grace, (Engineering Administration Dept., Case Institute of Technology, Cleveland, Ohio)
(The Tool Engineer, v. XXXVI, n. 5, May 1956, p. 73-79)

The authors first discuss some of the basic philosophies of operations research as a problem solving procedure. The technique of analyzing a situation, collecting data, and solving the problem are illustrated with an example in production scheduling. Here, two different cutting torch tips can be manufactured by several different routings through the shop. The formula is set up to minimize total cost for the production required. The solution is then found for the example described.

A CONTINUATION OF THE BEST IN INDUSTRIAL ENGINEERING, by George P. Champion, (Senior Operations Research Analyst, Lockheed Aircraft Corporation)
(The Journal of Industrial Engineering, v. VII, n. 4, July-Aug. 1956, p. 143-147)

This article describes operations research from the standpoint of an industrial engineering tool. Among the various topics discussed are: "What It Is", "Who Is Involved", "When There Is A Difference", (The difference between the industrial engineer and an operations research man), "Where Does It Work", "How It Operates", "Tools" (Brief description of the various basic techniques used), "Terms", "Why It Works".

SEQUENTIAL DECISIONING TECHNIQUE FOR OPTIMIZATION OF COMPLEX SYSTEMS, by Ram Vasqani, (Operations Research Group, Case Institute of Technology)
(The Journal of Industrial Engineering, v. VII, n. 4, July-Aug. 1956, p. 174-178)

This article describes a method or experimental technique that can be used in situations where the rules which govern the system are not known or where the system is too complex to be handled by the usual mathematical manipulation of operations research. "response surface technique" is suggested. The method of approach, and limitations are given. An example of a specific problem is worked out in detail. The particular problem used is the analysis of a system entrusted with the bombing of enemy targets. The author states that applications of the technique have been made in the chemical industry and that it may be applicable to other industrial, management sciences, and military decision making situations.

BOOK REVIEWS

W. D. Baten, Editor

26 University Drive, East Lansing, Mich.

MODERNE QUALITATSKONTROLLE, "Modern Quality Control," in German, by A. H. Schaafsma and F. G. Willemze, 468 pages, 8 × 6, 1955: Philips Technische Bibliothek, Eindhoven, Netherlands. Reviewed by N. L. Enrick.

This book carries the sub-title "Statistical and Organizational Foundations for Building-Up Quality" (Statistische und Organisatorische Grundlagen der Qualitatsgestaltung), but the primary emphasis is on statistical methods, covering tabular presentation, frequency distributions, control charts, sampling plans, significance testing and elementary correlation. Managerial and organizational aspects are treated very briefly. Based on the authors' association with the Philips Werke in the Netherlands, the illustrative examples are drawn from electrical and electronics applications.

There are many good examples, graphs and tables. However, the material on single, double and sequential sampling is incomplete in that it does not include all major developments of the past four to five years. This lack of complete up-to-dateness also applies to the literary references.

STATISTICS FOR MANAGEMENT, A SIMPLIFIED INTRODUCTION TO STATISTICS, by B. J. Mandel, XII plus 408, 1956, published by Dangary Publishing Company, Baltimore, Maryland. Reviewed by W. D. Baten.

This book presents an excellent broad outline of many of the objectives of statistics which management will profit by knowing. It contains good discussions of scientific methods of collecting information and advantages of securing secondary data, i.e. data that have already been collected and made available in public reports, private records, etc. The author has made the material suggestions of what might be accomplished by careful planning, thoughtful organizing and the proper use of statistical techniques. The admonition to carry out painstaking preliminary steps before undertaking the solution of any problem runs throughout the treatise and should cause the reader to realize the importance of the scientific approach to worthwhile investigations.

Sampling and risks involved are well presented in three chapters, which reveal many of the fundamentals that are essential for understanding the heart of statistics —sampling.

This book treats of frequency distributions, measures of central tendency, variability, sampling, correlation analysis, time series, index numbers and graphic presentation of data.

The chapter on time series is too brief and does not adequately treat this phase of statistics. The proposed problems appear to be academic and not for people in responsible management positions.

The appendix contains tables of squares, square roots and reciprocals of numbers from 1-1000 and areas "under" the normal curve.

Problems Department

THOMAS A. BUDNE
PAUL C. CLIFFORD
Co-editors

P. C. Clifford, 39 Norman Road, Montclair, N. J.

One of the organizational problems that plague some quality control organizations is that of dual responsibility. The advantages of dual responsibility are well illustrated by the Problems Department. By having two editors who manage to shuttle responsibility back and forth like a shuttlecock, we are able to get less material into print than any other department in this journal. Our alibis are just as good as any the quality engineer has to offer when quality goes to pot, and just as unconvincing. However, precluding another year abroad or change of location or the youngest child getting measles, we plan to appear with problems and suggested solutions in every other issue from now on. However we still have a strong feeling that this process is badly out of control, and we are unwilling to accept any penalty clauses in the contract. Like you, we still reserve the right to blame all our troubles on the raw material—in this case the problems submitted.

NEW PROBLEMS:

Problem 17. Submitted by M. C. Bugonian, Endicott, N.Y.

We desire to use Dodge's AOQL Plan for Continuous Production with an AOQL of 1.0 percent and an f value of 50 percent, thereby requiring a clearing sample of 27 pieces. The intersection point of a 1.0 percent AOQL value and a 50 percent f value, when carried across horizontally to the right on the chart, provides a p_t value of approximately 0.35 percent. If our interpretation is correct, this means that a run of 1000 parts with more than 0.35 percent defective has a probability of less than 0.10 of being allowed through unscreened. However, we would expect that a plan with a 0.35 percent value for p_t would have an even smaller value for its AOQL or conversely, a plan with a 1.0 percent AOQL would have a higher value for its p_t. We are particularly interested in knowing the worst percent defective in a run of 1000 parts which will be accepted by the plan we have outlined. (Note: The Dodge plan referred to can be found in most S.Q.C. textbooks and in the November 1947 issue of I.Q.C.). And from an ASQC member in Italy:

Problem 18. Submitted by S. Oberto, Milan, Italy.

How should the size of a sample and the sampling frequency be defined in the control of the quality of a productive process, both with the variables and attributes methods? This problem is of considerable economic interest and, so far as I know, has not been dealt with to any extent in technical literature. I believe there are only a few brief references, such as that of Duncan, *Quality Control and Industrial Statistics*, or that of Cave, *Le Controle Statistique de Fabrications*, published in France.

Suggested Solutions:

Problem 14. (May 1955 issue). Solutions suggested by Paul Berliner, New York, N.Y. and Donald L. Smith, Rochester, N.Y.

In effect, the first part of this problem asked for the mean and standard deviation of the distribution of the smaller of a sample of two drawn from a normal population. If t has the normal probability density function, f, then the probability density function of the smaller, t_s, in a sample of two is given by:

$$g(t_s) = 2f(t_s)\int_{t_s}^{\infty} f(t)dt$$
$$= 2f(t_s)\ [1-F(t_s)]$$

where F is the cumulative normal distribution function. The mean and standard deviation of t_s can be obtained from the above function or can be found directly in the tables for order statistics in the following references:

(1) Hastings, Mosteller, Tukey and Winsor, "Low Moments for Small Samples; A Comparative Study of Order Statistics," *Annals of Mathematical Statistics*, Vol. 18, No. 3, Sept. 1947.

(2) Goodwin, "Some Low Moments of Order Statistics," *Annals of Mathematical Statistics*, Vol. 20, No. 2, June 1949.

(3) Teichroew, "Tables of Expected Values of Order Statistics and Products of Order Statistics for Samples of Size Twenty and Less from the Normal Distribution," *Annals of Mathematical Statistics*, Vol. 27, No. 2, June 1956.

For this problem, the mean operating time of the system will be $t' - 0.5642\sigma_{t'} = t' - 0.5642(0.002t')$
$= 0.9988716t'$.

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The standard deviation will be $0.8256\sigma_{t'} = 0.8256(0.002t') = 0.0016512t'$.

The second part of the problem asked for the individual part reliability required, such that a system which consists of four such parts and which functions when any three parts function will have a system reliability of 0.95.

Problem 16. (June 1956 issue). Solutions suggested by Osmer Carpenter, Kalamazoo, Mich., John W. Hamblen, Stillwater, Okla., Charles Hicks, Lafayette, Ind., and Donald L. Smith, Rochester, N. Y. All the above contributed substantially the same answers to the question, "How is the constant, c_2, derived?"

The constant, c_2, is required because the expected value of σ is not σ'. In other words, the average of a large number of standard deviations, computed from samples of size n and all drawn from the same normal population, is not equal to the standard deviation of the population, particularly when the samples are small. The exact relationship is $\bar{\sigma} = c_2\sigma'$

For a sample drawn from a normal population, χ^2 is defined as

$$\chi^2 = \frac{n\sigma^2}{(\sigma')^2}$$

This leads to:

$$\sigma = \sigma'\sqrt{\frac{\chi^2}{n}} = \frac{\sigma'\chi}{\sqrt{n}}$$

Hence the mean or the expected value of σ can be found from the first moment of the χ distribution which is known. The r^{th} moment of

$$\chi = 2^{r/2}\frac{\left(\frac{n-3+r}{2}\right)!}{\left(\frac{n-3}{2}\right)!}$$

Hence for $r = 1$, the first moment is

$$\sqrt{2}\frac{\left(\frac{n-2}{2}\right)!}{\left(\frac{n-3}{2}\right)!}$$

Thus we find that the expected value of σ is

$$\frac{\sigma'}{\sqrt{n}}\left[\frac{\sqrt{2}\left(\frac{n-2}{2}\right)!}{\left(\frac{n-3}{2}\right)!}\right]$$

$$= \sqrt{\frac{2}{n}}\frac{\left(\frac{n-2}{2}\right)!}{\left(\frac{n-3}{2}\right)!}\ \sigma'$$

from which

$$c_2 = \sqrt{\frac{2}{n}}\frac{\left(\frac{n-2}{2}\right)!}{\left(\frac{n-3}{2}\right)!}$$

The solution for c_2, therefore, involves the expansion of the two factorial terms in the right-hand fraction. For a general term of the form (k/2) the factorial expansion, when k is odd, is

$$\left(\frac{k}{2}\right)! = \left(\frac{k}{2}\right)\left(\frac{k-2}{2}\right)\left(\frac{k-4}{2}\right) \cdots \left(\frac{3}{2}\right)\left(\frac{1}{2}\right)\sqrt{\pi}$$

Therefore for $n = 5$

$$c_2 = \sqrt{\frac{2}{5}}\frac{\left(\frac{3}{2}\right)!}{\left(\frac{2}{2}\right)!} = \sqrt{\frac{2\pi}{5}}\left(\frac{3}{2}\right)\left(\frac{1}{2}\right) = 0.8407$$

As Donald Smith points out, the formula for c_2 as given in the 1951 A.S.T.M. "Manual on Quality Control of Materials" is incorrect due to a typographical error in which the square root sign is misplaced. The error has been corrected in later printings of this Manual.

AMERICAN SOCIETY NEWS

Apology: We offer apologies to:
David S. Chambers
University of Tennessee
Knoxville, Tennessee
for not acknowledging in IQC his election to Fellow, ASQC which occurred last April. Belatedly, but none the less warmly, we extend our congratulations.

Recognition: We happily announce a slate of District Representatives for the 1956-57 fiscal year, with their company affiliations:

District 1
R. Shaw Goldthwait
Collyer Insulated Wire Co.
Pawtucket, R.I.

District 2
Marsh B. Gwynn
Eastman Kodak Co.
Rochester, N.Y.

District 3
John Major
Colgate Palmolive Co.
Jersey City, N.J.

District 4
Allin P. Deacon
Consultant
Brantford, Ontario, Canada

District 5
Richard Schin
Western Electric Co.
Allentown, Pa.

District 6
Mahlon H. Replogle
Olin Mathieson Chemical Co.
Baltimore 2, Md.

District 7
John F. Occasione
American Steel & Wire Div.
Cleveland, Ohio

District 8
Ervin F. Taylor
Westinghouse Elec. Corp.
Cheswick, Pa.

District 9
Virgil Alexander
J. D. Adams Div.
Le Tourneau Westinghouse
Indianapolis, Ind.

District 10
W. D. Baten
Michigan State University
East Lansing, Mich.

District 11
Marjorie L. Sutherland
Clopay Corp.
Cincinnati, Ohio

District 12
Harvey E. Maxwell
Caterpillar Tractor Co.
Peoria, Ill.

District 13
Sam L. Grasso
Inland Automatic Inc.
Omaha, Nebr.

District 14
C. T. Shewell
Humble Oil & Refining Co.
Houston, Texas

District 15
Robert H. Mayes
Schenley Industries
Louisville, Ky.

District 16
Geo. M. Cohan
Hill Air Force Base
Ogden, Utah

These people are presently taking the necessary steps preliminary to conducting the election in each District for National Directors for the 1957-58 fiscal year. They also perform a liaison between ASQC and the sections and are ready to assist sections in their District in any way they can.

Technical Literature: A recently adopted ASQC policy is to make available to the membership some of the technical literature that has been on our shelves for some time. There are two reasons for this action:

1. We need the space for newer publications.
2. The literature can be used to far greater advantage as handout material by membership committees in the sections and divisions than by occupying space on our shelves.

Individual members may request single copies at 25 cents each (prepaid) to cover mailing and handling charges. Section and Division officers may request copies in bulk at a nominal fee to cover bulk handling and mailing costs. This offer is open only to paid-up ASQC members and to Section and Division officers.

Available at present are:
1952 Convention Transactions
1954 Automotive Supplement #1
1953 Aircraft Supplement #1

Service: With the move of our headquarters office to Milwaukee we set up the ASQC membership roster on punched cards at Workman Service in Chicago. This was done to provide better service to members and sections. Admittedly there have been some bugs to get out of the procedures but they are being gradually eliminated. Section secretaries and others have received membership lists in one form or another from Chicago and they will continue to do so. It is only proper therefore to inform the membership through this medium of a part of the service performed.

1. On the 15th of each month each section receives a list of changes in and to its membership made up from information received in the Milwaukee office in the previous month. These are of many kinds such as address changes, transfers into and out of sections, renewals, new members, upgrades, joining a Division, dropping a Division, change of employment, change of title and numerous other details.
2. In addition to the change list, on the 15th of November, February, May, and July each section will receive a complete membership list of their membership as it is in the ASQC office. This will enable the section to check the ASQC list against section records.
3. On the 15th of the odd months each Division will receive a complete list of its membership as the ASQC office has it.
4. Any section, division or other ASQC group may obtain labels for mailing. The office needs six weeks lead time for this service.

The direct collection of dues experiment in which the Metropolitan, Chicago, Milwaukee and San Diego Sections are participating is progressing very well. The reason for limiting the program to only four sections this year is to uncover and eliminate problems as they arise. Next year, when it is hoped that all sections will be participating, the procedure should be fairly well shaken down. At present there is a three-way check on memberships in the four sections mentioned above.

1. The change lists issued on the 15th of each month as described above.
2. The membership report issued by the Milwaukee office each month.
3. Local section records.

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This procedure takes a big work load off of section secretaries and makes for uniform processing of memberships.

New Section: We welcome the Kankakee-Joliet Section as the 94th section of ASQC. This group was sponsored by the Central Illinois Section and they have gotten off to a rousing start. Their officers are:

Chairman:
John F. Jeffrey
Caterpillar Tractor Co.
Joliet, Ill.

Vice Chairman:
Warren J. Chamberlain
General Foods Corp.
Gaines Dog Foods
Kankakee, Ill.

Secretary-Treasurer:
Rudy Peterson
David Bradley Co.
Kankakee, Ill.

SUPERVISOR'S CIRCLE

PAUL A. ROBERT, *Editor*

Gruen Watch Company, Time Hill, Cincinnati 6, Ohio

Effective Control of Source Inspection

R. O. SPRAGUE, *Hughes Aircraft Company, Tucson, Ariz.*

Comments of The Editor

This article on the control of source inspection, while of primary interest to the larger companies who make it a practice to place inspection personnel in vendor's plants, also emphasizes the need for communication. The interpretation and transmission of quality requirements within your organization, to the vendor, and within his organization, is one of the most important functions of quality control.

With the current expansion of missile manufacturing programs, Source Inspection of vendor and sub-contract items is being recognized as an important factor in the attempt to control and improve end-product reliability. Until recently, Source Inspection activities in widespread vendor plants has been conducted on a hit and miss basis—with the contractor relying on the ability and luck of the individual Source Inspector, taking a calculated risk in accepting vendor items without further costly and time-consuming in-plant inspection and test. The Source Inspector, once assigned to an area of responsibility, was on his own; an orphan to be guided by remote control, too far removed from home base to be subject to company rules and regulations. The magic psychological effect of his appearance in a vendor's plant, his surveillance of the vendor's quality control system, and the elaborate paper-stamping routine was considered adequate to assure vendor compliance. As a result of this approach, the contractor often found himself facing costly production shortages after fighting many after-the-fact quality problems that should have been discovered and corrected at source.

Source Inspection functions, to be effectively controlled, must be recognized as an integral part of the contractor's quality control system. Effective control of this function can be accomplished only by methodical preparation of the Source Inspector and the vendor for the parts they must play in the vendor/sub-contract programs and proper administration of Source Inspection activities by responsible Quality Engineering personnel in the contractor's plant.

The Quality Engineering group performs the following basic steps in preparing the vendor and Source Inspection personnel for their active responsibilities.

1. A Quality Survey of the vendor's facility is conducted to determine the adequacy of his quality control system. Desired improvements are recommended, and the vendor is acquainted with the contractor's Source Inspection and Quality requirements.
2. The procurement package is reviewed for Quality and Source Inspection requirements. Based on the vendor's geographical location, complexity of the vendor item, and the vendor's ability to produce quality products, the Source Inspection requirements are determined and made a binding part of the Purchase Order package.
3. Complete Inspection Test Instructions are prepared and maintained to current engineering requirements as specified by the Purchase Order.
4. A Job Instruction, detailing all applicable company, divisional and departmental procedures, is prepared.
5. Source Inspection personnel, in conjunction with the Inspection Engineer, reviews the blueprint and specification information to thoroughly familiarize himself with the item quality requirements.

Source Inspector is supplied with a complete package of inspection and engineering information, consisting of blueprint and specifications, Purchase Order copies, Inspection Test Instructions, Job Instruction and applicable Quality Procedures; all of which are maintained to current engineering and purchase order requirements by the contractor's Inspection Engineering group. Inspection Engineers are assigned specific vendor responsibilities and maintain close quality liaison with the Source Inspector and vendor. Quality problems in the vendor's plant are forwarded to the Inspection Engineer by the Source Inspector, and conversely, discrepancy information is fed back to the Source Inspector by the Inspection Engineer. By this method correlation of quality problems and effective corrective action is quickly accomplished.

The Source Inspector is required to submit daily activity and weekly summary reports, detailing his activities in his assigned area. This information, correlated with the cognizant engineer's activities, is monitored by the supervisor, enabling him to spot troublesome areas and

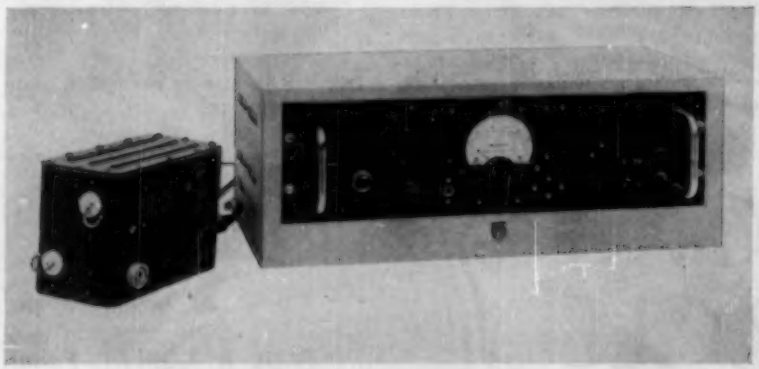
correct or eliminate weak links in the Source Inspection chain before serious Quality and Production problems are encountered.

The Source Inspector, selected for his quality background, ability to get along with people, and knowledge of over-all product quality requirements, is now recognized as an active member of the contractor's Quality organization. He is assigned specific responsibilities with detail instructions to assist in the performance of his daily activities. He is on a direct pipe-line to his home plant where competent Quality Engineering personnel are ready to assist and inform on all problems that may arise in the vendor's plant. He is being utilized to the utmost and the results of his efforts are obvious in the higher quality level of vendor and sub-contract items being received in the contractor's plant. No longer can he be considered a remote-control paper-stamping magician.

What's New?

ROY A. WYLIE, *Editor*

When inquiring about "What's New?" items, please mention INDUSTRIAL QUALITY CONTROL



The Ekco Model 1079C Vibrating Reed Electrometer specifically developed for ionization current measurements requiring a very high order of stability and precision, such as are encountered in radio-activity and pH studies, has been introduced by **American Tradair Corp.**, 34-01 30th St., Long Island City 6, N. Y. The unit was designed by the British Atomic Energy Establishment and is produced by Ekco Electronics, Ltd. to provide a lightweight, compact electrometer using a true resonant reed type of capacitor which makes it inherently free from driving voltage fluctuations. Specifications are:

Stability—
± 1 mv, day-to-day

Sensitivity—
0.03 uua full-scale reading at max.

Ranges—
0-30, 0-100, 0-300, 0-1000 mv.

Input—
Internal, switch-controlled 10^8, 10^{10}, 10^{12}, ohm resistors

Output—
Operates with 1 ma. or 100 mv, recorder

Power—
110-220 or 200-250 v., 40/60 cps., 40W

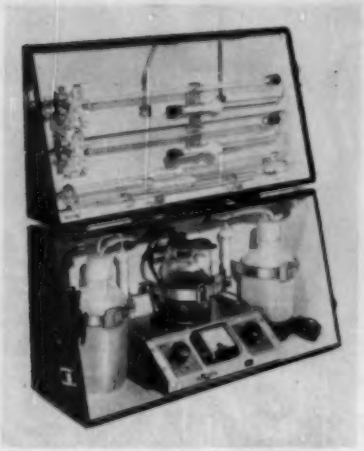
Weight—
Only 29 lbs., complete with cables.

★ ★ ★

Quality Control Departments engaged in training programs will be interested in the "Conference Caddy" manufactured by **A. J. Christian and Sons**, 614 Jefferson Ave., Rochester 11, N.Y. The "portable conference room" is a unit combining in one piece of equipment the equivalent of 72 sq. ft. of "blackboard" space, the equal of 8 easels for poster boards and a suitable picture screen for slides and motion pictures. The cabinet unfolds to form a stand and easel containing a roll of paper 24 inches wide for use in the writing board. Aluminum extension arms are used to provide 3 ft. or 6 ft. of extension from either side. Each 3 ft. extension arm has hooks spaced to hold one 22 × 28 inch and one 11 × 28 inch poster board, thus providing a maximum of 8 poster boards on display at one time. Poster boards are coated on both sides making available 16 display surfaces without changing boards. Boards are furnished with grommets attached to provide for repeated use. The writing board itself, with a normal writing surface of 24 × 30 inches, can also be used as a screen for motion pictures or slides. A dacron cloth screen 4½ × 5 feet with grommets attached for suspension from the arms is also available. The portability of the

"Conference Caddy" permits use at different locations and for more than one department within an organization. It takes only 2½ minutes to completely set-up or take down the "Caddy". Complete weight is 63 lbs. and the unit will easily fit into the trunk of a car.

★ ★ ★



A new, portable moisture determinator for use in field stations, laboratories, or quality control points, is announced by **Central Scientific Co.**, 1700 Irving Park Rd., Chicago, Ill. The Cenco Karl Fischer Moisture Determinator is completely self-contained, weighs only 22 pounds and can analyze liquid, solid and gaseous samples without removing the basic apparatus from the case. The instrument is recommended for moisture determinations on petroleum products, edible oils, soaps, fats, waxes, dry food products, paper, and a wide variety of other materials. The plastic-covered wooden case houses all equipment needed for accurate moisture determinations, except the pipettes and chemicals. These items are selected by the user to fit individual needs. Operation is on 115 volt, 60 cycle current. Accuracy of the determination varies from plus or minus 10 percent in the 0 to 100 parts per million range, to plus or minus 0.2 percent in the higher ranges. Additional information is available from Central Scientific.

★ ★ ★

NEW LITERATURE

An eight-page bulletin on their complete line of hydrometers and thermo-hydrometers for use when accurate indications of specific gravity or other density scale are required, has been issued by Precision

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Thermometer and Instrument Co., 1434 Brandywine St., Philadelphia 30, Pa.

The Sheffield Corp., Division 610, Dayton 1, Ohio, has issued a new 12-page catalog containing the principles of air-gaging with the column Precisionaire. The catalog features basic tooling for inspecting internal and external dimensions and conditions, and types and sizes of adjustable air-gage tooling.

POSITIONS WANTED

Address all replies to box number references to: American Society for Quality Control, Room 6197 Plankinton Bldg., 161 W. Wisconsin Ave., Milwaukee, Wis.

QUALITY CONTROL AND DEVELOPMENT ENGINEER

Fully experienced in Statistical Quality Control, Industrial Experimentation, Management of QC, etc. Desires work New England or New York area. Please reply to Box 13F1 at the above address.

POSITIONS AVAILABLE

Address all replies to box number references to: American Society for Quality Control, Room 6197 Plankinton Bldg., 161 W. Wisconsin Ave., Milwaukee, Wis.

QUALITY CONTROL ENGINEER

Outstanding opportunity with leading San Francisco Bay Area electro mechanical manufacturer in expanding quality control program. Engineering degree plus minimum of 3 years manufacturing experience required. Knowledge of statistical theory desirable. Please forward complete resume. All replies held confidential. Please reply to Box 13T1 at the above address.

CHIEF INSPECTOR

To direct all mechanical and electronic inspection activities in expanding quality control program. Engineering degree plus minimum of five years of heavy inspection supervisory experience required. Knowledge of statistical theory desirable. Position is with leading electro mechanical manufacturer in San Francisco Bay Area. Please forward complete resume. All replies held confidential. Please reply to Box 13T2 at the above address.

QUALITY CONTROL ENGINEER

Opening for Industrial or Textile Engineer with 2 to 3 years' experience in Quality Control for newly established department with leading Textile Manufacturer. Applicant must be young, aggressive and inquisitive. Reply, stating experience and salary requirements to Box 13T3 at the above address.

California appliance manufacturer requires Chief Quality Control Manager or Assistant Manager for major appliance manufacturer. Experience in establishing manufacturing standards, specifications, etc. $12,000 to start plus fringe benefits. Prefer degree in engineering or science. SQC course imperative.

Send resume to
HERGENRATHER ASSOCIATES
1420 Statler Center
Los Angeles 17, Calif.

QUALITY CONTROL ENGINEER

Two years experience in quality control and application of statistics to industrial problems. Experience should include design and management of quality control systems. A knowledge of quality control records, forms, reports, and all types of sampling plans and control charts is essential. Should be capable of process analysis to isolate sources of poor quality and make recommendations for correction. Engineering and mathematical background desired.

GATES RUBBER COMPANY
99 South Broadway
Denver, Colorado

QUALITY CONTROL STAFF ENGINEER

To study machine and instrument capabilities, prepare quality control reports, set up inspection auditing systems and analyze inspection reports to point corrective action. Should have a good background in QC work, preferably in metal working industry. An engineering degree is desirable, but not necessary. Send complete resume, including education, experience, and salary requirements to:

Personnel Manager
NORMA-HOFFMANN
BEARINGS CORP.
Stamford, Connecticut

QUALITY CONTROL ENGINEERS STATISTICIANS

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Write:

Bruce Bollerman
32 Brookdale Gardens
Bloomfield, New Jersey

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Outstanding opportunity for experienced Quality Control Engineer to set up new program. Applicant should have a degree in Chemical Engineering or Chemistry with at least four years experience or training in statistical quality control and statistical techniques in the chemical processing industry. Some graduate work in statistical quality control helpful.

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Challenging salaried position for a statistician in research and process development department. Requirements for position include knowledge of statistical methods and their application to problems in organic research, process development, and polymerization studies. Statistician will be responsible for recommending experiment design to chemists and engineers and to aid in the interpretation of data.
Permanent location in Akron, Ohio. Liberal company paid benefits including company hospitalization, pension and life insurance plans. Reply should give details of education, work experience, and should include salary required.

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Staff Employment Section 564,
SANDIA CORPORATION
Albuquerque, New Mexico

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FIELD QUALITY ENGINEER

To act as a quality coordinator between the company and the customer at military installations. Analyze and provide feedback on field performance of weapons systems and field test equipment. Coordinate his activities with company reliability and engineering groups for the general improvement of the product and its proper protection in transit and storage. Prepare reports as required to keep the maintenance depot and the company informed of any quality problems found in the field.

These positions require an M.E. or E.E. degree with a mathematics or engineering background, and actual shop experience in the application of statistical techniques to electronics manufacturing operations.

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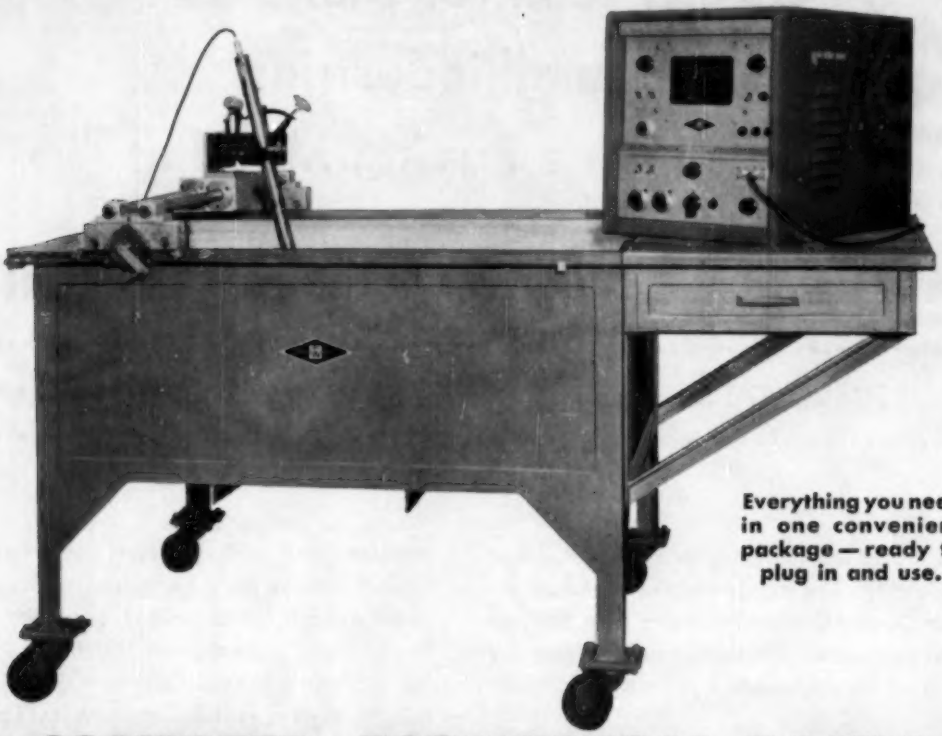

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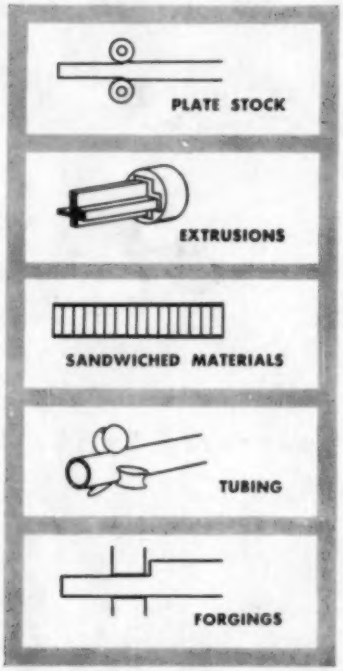
This Ultrasonic Test Unit Model PT 1001 lowers inspection costs, stabilizes high standards in quality control, and permits analysis of fabrication techniques. Complete information on request. Our local representative is available to discuss your problem.



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